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Engineering News-Record

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Water Supply

Bay City Water Works Displaces Two Old Plants

Sewers

Separate Sludge Digestion for Small Towns

Roads and Pavements

Construction of Hydraulic Fill Road Embankment

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Concrete

Specifying Concrete by Water-Cement Ratio Alone

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WICHT
Editor

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Notable Hydraulic Fills

EMBANKMENT construction of water-borne earth is featured in this issue in two very different structures and, coincidentally, by two quite different methods. On the Alouette dam train-hauled earth is sorted and spread into embankment by hydraulic giants. On the Saginaw-Bay City highway hydraulic dredges are making a true hydraulic-fill road grade averaging 100,000 cu.yd. a mile for eight miles. The dam operation is quite insignificant in volume, as notable hydraulic-fill dams have run in size, but the road operation is not only one of the few but also, we think, the largest road job ever undertaken by hydraulic methods. It is indicated that the modified hydraulic-fill process at Alouette was inspired by fear of slips, with the material used, if straight hydraulic fill, with its comparatively uncontrolled volumes of water, were employed. In the road work hydraulic fill was selected because, with a river parallel and close to the road and needing deepening, for a borrow pit, hydraulic dredging was the cheapest way of moving earth and consolidating fill which would be required to carry a paving slab at the earliest safe moment possible. Of the methods in detail on either operation little that is exceptional may be noted; both have been monotonously straightforward operations. There is importance, however, in the fact that both operations, and particularly the unusual road work, indicate the increasing recognition of water carriage and consolidation as an embankment construction process.

Fine Grading Cost

HOW close can road subgrade be finished? One construction engineer speaking recently before a convention of public road officials asserted that it was no trick at all to keep as close as ½ in. to the theoretical plane. Commonly contractors think they do well to keep within ½ in. in variation. Universally they finish the subgrade low, generally from ½ to ½ in. below the theoretical elevation. Core drilling has caused this practice. Not confident of the precision of his subgrading the contractor, fearing penalization for shallow slab, plays safe by dropping his sub-grade level. Often doubtless his thought is also that it is cheaper to put in a little more concrete than it is to "sand-paper" the ground. Nothing so irks the earth mover as close grading. Therefore he is a little deaf to the argument that leaving the subgrade low costs more than to finish it close. How much? The engineer who said that it was no trick to finish subgrade within ½ in. stated also that $500 a mile spent to get this subgrade nicety would save $1,200 to $1,500 a mile in extra concrete. At the last Road Builders' meeting C. J. Moritz, an Illinois road contractor, analyzed costs more definitely, and found that they run into amounts ranging as high as $1,500 a mile of 18-ft. road, on the basis of an average excess thickness of slab of ½ in. The paper gave no contrasting costs of finishing subgrade to ½ or ¼ or ½ in. Indeed it may be doubted if such cost records exist. Casual inquiry of grading superintendents brings guesses ranging from 1 to 15c. more a square yard to finish to ¼ in. instead of to ½ in. The generally expressed opinion is that finishing to ½ in. is impracticable with methods now available. We require more figures of the cost of fine grading.

Separate Sludge Digestion

FEW engineers outside of the strictly sanitary field realize the extent to which the smaller cities have been turning to the separate sludge-digestion method of handling this most troublesome by-product of sewage treatment. The list of ten cities and description of the plant at Hartford, Wis., elsewhere in this issue, indicate a laudable attempt to solve the sewage problem of small cities in a way that is not too complicated or expensive in operation and still produces a sufficiently satisfactory effluent to permit its discharge into the ordinary water course. The great advantage of separate digestion from the standpoint of construction is the shallow depth of tanks required, as compared with the depth of two-story tanks. In some places this saving in depth may help in operation also, by making it unnecessary to use pumps or at least by requiring pumps for lifting the sludge only. Time will tell whether the care of the agitating mechanism for such clarifiers and digestors as are described in Mr. Donohue's article, and the cost of keeping them and sludge pumps going, when the latter are required, will be better provided than is the case with lesser operating requirements of the many "disposal plants" at present used mainly to ward off complaints, legal, official and private. Certainly the power cost is not high, but operators with some training are essential. Anything that will provide better operation of the small sewage-works of the country is to be welcomed. The lure of machinery with or without the action of microscopic organisms may help.

Why Not in Virginia?

VIRGINIA stands almost if not quite alone among American states in having a constitution that forbids the assessment of benefits for local improvements against abutting lands. A constitutional amendment authorizing the practice in that state was defeated, 51 to 31, in the lower branch of the Legislature recently, 6 of the 7 delegates from Richmond voting no, as did both of the two from Portsmouth, and the one each from Lynchburg and Petersburg. A similar bill, introduced later in the Senate, was defeated there, 22 to 14, although it would not have been effective in any city until adopted by ordinance and approved by a referendum vote. The League of Virginia Municipalities (Travelers Building, Richmond) is pledged to an educational campaign to remove this anomalous condition in Virginia. Engineers in that state might well throw themselves into the campaign.

Simplified Concrete Proportioning

INASMUCH as the Portland Cement Association has been sponsor for the theory that the ratio of cement to water is the most important factor in concrete proportioning it was only natural that it should put the theory to practical use when it built its new building at Chicago. The paper by Messrs. McMillan and Walker abstracted on another page of this issue tells how successful was the practical application and how, with proper inspection and contractor co-operation, the proportioning of concrete may be simplified.

The P. C. A. building concrete was proportioned according to the methods proposed by Mr. McMillan some years ago but not until now applied to a job of any sizable proportions. That method merely takes the water-cement ratio theory as a statement of fact. For a given aggregate there is an optimum amount of water per bag of cement; find out by trial that amount, specify its use and then add aggregate to get the desired workability. The contractor, theoretically at least, will add as much stone and sand as he can because the more he adds the cheaper will be the concrete, but he will be automatically restrained by the fact that too much stone will make the concrete too harsh to work or place —and the inspector further stands by to determine just when the workability is right. Moisture content of the sand, according to the authors, is not so important as it has been made out to be by some, because it is fairly constant during one day's run and is readily determinable by simple tests.

As proof of the desirability of the method the results on the P. C. A. building are offered. They show a concrete close to the strength predicted for the varying percentages of water and of an acceptable uniformity of strength. The contractor claims a considerable saving in cement, and appears to be quite satisfied with the specification as a working method; that is, there were no complications in system nor over rigidities of inspection which most contractors fear from any departure from the good old 1:2:4 concrete days. In short, the designer is satisfied that he has gotten the kind of concrete he wanted, the contractor made money, and the owner feels that the job is better and cheaper than it would have been under the conventional specification.

All this is most interesting to those who are designing and building concrete, as an indication of what can be done by this method when conditions are right. By right is meant absolute co-operation between an intelligent engineer who is seeking results and not merely following rules and an intelligent contractor who will follow instructions and adopt new methods. If either of the parties become overly self sufficient, if either too strongly sticks up for his own interpretation of the specification, the method must fail. In other words this new scheme of proportioning depends more on the spirit of the men than the text of the specification and unless there is the closest co-operation between the engineer and the contractor, and the utmost willingness to learn by both inspector and foreman, the old fashioned letter-of-the-law specification had better be kept.

There remains, too, one more comment. As in most of the latter-day theories of concrete placing, this one rests on strength as the proof of the pudding. The only other observation of any tendency toward permanence is the purely visual one for obvious honeycombing. If the concrete tests 2,000 lb. at 28 days and has no surface pits it is assumed to be satisfactory. Lacking any other test of permanence that is probably the best that can be done, but the obligation of future inspection remains. Those who are exploiting these newer methods of proportioning should make sure that periodical future inspection of some of these quasi-experimental structures be made for a record of behavior. There is little concern by any one that concrete placed by any of the accepted methods will fail from lack of strength. What is of concern is the possibility of gradually wearing away or breaking up.

Seattle's Latest Charter Proposal

FROM an engineering viewpoint the outline for a new charter submitted by the recently created Seattle Charter Commission goes a long ways toward the ideal. It provides for a "city business manager" whose jurisdiction, even though it falls considerably short of the usual council-manager standard, extends to all the engineering work of the city, including city-owned utilities, harbor improvements and fire protection. Rarely is so wide a range of engineering work centralized in one city department or better distributed among divisions. These eight divisions combined make up the larger part of the city's activities, especially in money spending power. The only major service not entrusted to the proposed Seattle manager — education aside, which rarely if ever falls to a manager—is the police department. As this is the rock on which many a city manager has been wrecked candidates for the managership of Seattle, notably those who are engineers, may be glad rather than sorry that they will not have to risk its dangers.

Looking at the charter outline from a broader viewpoint, those who believe in the centralization of all administrative powers in a single head will deplore the decentralization proposed at Seattle, all the more so because, with one exception, the work not entrusted to the city business manager is put in charge of boards with from 3 to 21 members. Fortunately the health department is single headed while the most important of these boards, the police, has the fewest members, and the largest commission, city planning, is only an advisory board. Of the remaining departments, all are quite frequently multiheaded, elsewhere, whether under the manager or not. A single police commissioner, however chosen, is the most approved and the most general practice. Good features of the outline are its provision for a short ballot, councilmen elected at large, even though they do represent districts—for which there is much to be said in a city the size of Seattle—and the centralization of engineering work, already emphasized.

The small power given to the mayor is less surprising when it is remembered that only last March the small adverse majority of only 111 votes on a charter amendment was all that kept the mayor from being eliminated and a city manager substituted. Evidently the people of Seattle have little use for a mayor, except as a ceremonial head, under the new scheme, but are willing to pay him handsomely nevertheless. By the same token, they are unwilling to go the whole measure of the council-manager plan.

The proposed charter, if it stands all the ordeals yet before it, will be a compromise measure, the result of

a campaign extending through two years or more, with two defeats for earlier proposals. It promises to give Seattle a good framework of government.

Continuous Structures to the Fore

IN RECENT years structural engineering practice has turned unmistakably toward fuller use of the continuous form of structure, both in the mesh or framed type and in the massive type. One phase of this departure from precedent was represented by the bold initiative of G. Lindenthal in planning the long-span Sciotoville bridge, and C. G. E. Larsson in designing the Bessemer & Lake Erie bridge over the Allegheny, two noteworthy examples of continuous construction, which largely because of this decisive precedent has come to be recognized as an acceptable and often superior system for long-span work. The recent extensive use of continuous spans in the new Willamette river bridges at Portland emphasizes the trend. Another phase is represented in the adaptation of continuous construction to concrete park bridges in Westchester County, with results so impressive in increased efficiency and esthetic range as to forecast an important influence on future short-span practice.

For a great many years the principle of simple-span or discontinuous construction held sway almost unchallenged—certainly in American structural practice, and only to slightly lesser degree in that of Europe. The definite aim was made in the design of every structure to resolve it into simple beams, columns and braces. Continuous construction was under suspicion, for reasons not without weight.

From the early days of modern scientific design it had been the objective of the structural engineer to proportion all parts of his structures for definite loads, and in order to approach as nearly as possible to the desired ideal state he aimed to carry the application of the lever principle as far as possible. Accordingly he built up every structure of simple levers throughout, if possible with pin joints, simulating the frictionless hinges or knife edges of the lever scale, or else with the nearest approach to such simple joints. This attitude of mind contributed to maintaining pin connection in favor, and reinforced the reasons of easy construction, low cost and compactness which gave this system its extensive use—advantages important even today, as indicated for example by the pin connections used in parts of the large trusses of the Stevens Hotel in Chicago, illustrated last week. A further reason contributing to the marked preference for discontinuous construction was a desire to localize disturbances due to movement, temperature change and various causes. This desire, expressed also in thoroughgoing provision of expansion joints in a structure, is entirely logical when taken by itself, but unfortunately it encounters many practical difficulties, not always readily foreseen.

Advancing requirements and the rise of new forms of construction within the last decade or two have had a great leavening effect on structural thought. The plank-covered floor supported by simple beams has been forced into the background by the continuous slab. The discontinuous pavement made of loosely-aggregated blocks has been replaced by slab or sheet pavement. Reinforced-concrete construction, inevitably and intimately concerned with continuity throughout, exerted an unceasing though perhaps unrecognized pressure against the old-time dominance of jointed, discontinuous construction. Progress in steel structural practice helped to popularize thinking in terms of continuous construction, through the influence of the complex cellular framework of the tier building. And it must not be overlooked that improvement of foundation practice—an advance often undervalued—was influential in transforming older conceptions, by doing away with the view that a foundation is necessarily uncertain and liable to compression, settlement or dislocation.

We have thus progressed far into a new range of structural thought, though we are not always clearly aware of it. It still remains to work out the application of continuity in varied practical forms, and to reshape numerous processes and conventions of the art accordingly.

The planning of the Westchester bridges is an important contribution to this present stage of development. It directs attention forcibly to the fact that a structure is inherently integral from footing to handrail, and that no great gain is realized from dissecting it into the elements of abutment and span. The gain in economy, simplicity, and freedom from many common bridge troubles that can be realized by planning the structure as an integral unit is brought clearly into view. At the same time, the Westchester work affords a suggestion of various practical considerations pro and con, that doubtless will attract the very careful attention and awaken the thought of the structural engineer—among them the relation of main structure to approaches, the influence of temperature, of alterations and replacements, and the like.

No less stimulating are the esthetic phases of the subject; for the continuity of the structure necessarily demands also a representation of this continuity in the external aspect, and involves abandoning the simple forms of arch, girder, abutment and wing wall. In this particular it is evident that extensive possibilities lie before us. Structural architecture has for uncounted generations reared itself on a segregation and separate emphasis of the component parts of the structure, and does not yet know how to express the structure as a simple entity.

Much has been done by the architectural and engineering designers of the Westchester bridges in dealing with this new problem. Their pioneering is not to be taken as a finished art, of course. While taste is notoriously variable and individual, we feel that some of the structures in question betray the architect's uncertain groping after appropriate form, in their superficial arch rings, suspension bridge outlines or other appliqué forms. The continuous rigid-frame bridge is worthy of its own expression, revealing rather than masking its characteristic resistances. Precedent inevitably clogs all esthetic expression, and perhaps nowhere more so than in architecture, but in time the true esthetic development of form will be accomplished, as a corollary of the structural application and development of the type.

Working out this structural development in all its phases is the problem which will have to engage the activities of many structural engineers in the early future. The proven possibilities and advantages of the continuous type are sufficiently important to claim its consideration for very many structures that will have to be built in the years immediately ahead.

Flow of Water in 54-in. Concrete Conduit, Denver, Colo.

Two Tests of Combined Length of 7.2 Miles Show Average $C_s = 0.395$ and C_w of 146.5 in Scobey and in Hazen Formulas and 0.01095 for Kutter's n

By Fred C. Scobey

Irrigation Engineer, U. S. Department of Agriculture, Division of Agricultural Engineering, Berkeley, Calif.

TESTS of a 54-in. reinforced-concrete conduit forming a part of the Denver water-works show a capacity greater by 15 per cent than that accepted for the best conduits a few years ago. These and the 1924 Tulsa tests of a conduit of the same size and material give confidence in the formula (given below) with $C_s = 0.370$ for the best concrete pipe. The high carrying capacities shown by the Denver and Tulsa tests, combined with a life estimated at 70 to 100 years, make necessary a readjustment of values in equating bids for pipe lines of different materials.

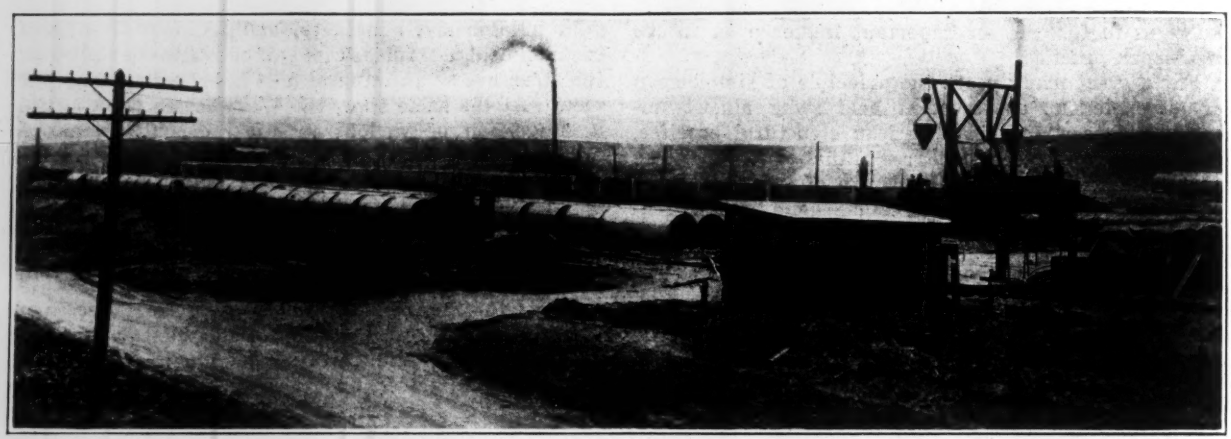
Before taking up the Denver tests I would suggest that if the data now available for all concrete pipes indicate the true trend of hydraulic laws then a constant value of C_w in the Williams-Hazen formula should not be used *for the same surface* throughout the range of sizes and velocities encountered but I am keeping an open mind to further evidence. In view of the wide present use of the Williams-Hazen formula I suggest that all test data made public be computed in terms of that coefficient, regardless of leanings of the author of the moment. I also suggest that the tables should show the values of Kutter's n although this formula has long been discredited for *computing the capacity of conduits under pressure.*

In 1921 the Denver municipal water-works completed work under the first contract for a 54-in. reinforced-concrete pipe trunk line, from Kassler filters, near the mouth of Platte Canyon, Colo., for a distance of about 5 miles in the direction of Denver. Here a cross connection was made to an old line going on to the city. During 1924 the concrete line was extended to Wynetka, near Littleton, a further distance of 4 miles. It is the intention ultimately to continue this 54-in. line on to Capitol Hill reservoir, in the eastern part of the city, a total distance of about 20 miles, as a through trunk line.

The 1921 pipe is practically straight in both horizontal and vertical planes. From Kassler to within a few hundred feet of the end, it lies in the gravel forming the first bottom land above the river. At the lower end it rises to the gentle slopes above the river bottom and the whole of the second contract—the 1924 pipe—was laid among these slopes. The new pipe also is quite straight in alignment but crosses numerous small gulches and is gently sinuous in the vertical plane.

Pipe Construction—All of this pipe is of the lock-joint type, precast units in 12-ft. lengths, heavily reinforced with steel hoops, bored and wired at each intersection with longitudinal rods. These rods terminate in heavy galvanized rings which assure true diameters at the section ends and likewise assure that the reinforcement comes uniformly in the shell since the rings themselves serve as the mandrels spacing the forms. The wet concrete, of a very rich mixture, is well spaded against oiled sheet-steel forms. Steam is then applied to the pipe unit under a canvas hood, effecting a thorough and uniform cure. The units are handled in the field with locomotive cranes which slip one piece of pipe smoothly inside the last one. In the space beween the male and female rings a heavy lead gasket is placed which is later calked from the inside through an annular triangle. This triangular ring is then filled with neat cement, screeded to a perfect transition between adjoining ends of pipe. A blowout of the lead gasket cannot take place. Joints in the finished line can be located by color only, not by touch.

In June, 1925, the writer determined the carrying capacity of both the 5-mile and 4-mile sections of this line, both conveying filtered water, one since 1921 and the other since late in 1924. The pipes are identical so far as the original interior surface is concerned, being constructed by the same organization using the same methods.



PIPE YARD MAKING 54-IN. REINFORCED-CONCRETE PIPE IN 12-FT. LENGTHS FOR DENVER WATER-WORKS
View taken in 1924 shows double concrete hoppers on gantry crane; men spading wet concrete around forms; units in vertical position being steam-cured under canvas hoods; finished units on skids along industrial track.

Manometers—Four mercury manometers of the U-tube type were set up, two on the old line and two on the new line. These manometers were identical in assembly except as to length of column. After assembly they were wired securely to light pieces of sugar pine,

LOWERING 54-IN. X 12-FT. PIPE INTO TRENCH BY LOCOMOTIVE CRANE

making sure that the two graduated gage glasses were parallel in both planes. These manometers were then wired to iron air-vent pipes, a plumb-bob being used to make certain that all glasses were truly vertical; the vent pipe, of course, merely served as a post for the gage. A thermometer was hung on each manometer about the middle of the long mercury column so that proper correction in column length reduced all columns to that of a common temperature—taken as 15 deg. C., as this is the temperature at which hydrometers are tested at the Bureau of Standards in Washington. Hydrometer readings of the water flowing in the pipe co-ordinate the specific gravity factor of the mercury for distilled water with the proper specific gravity for the water in the pipe forming the column balanced by the mercury column.

Piezometer Connections—Pressure tubing formed the connection between the manometer and the concrete pipe under the manhole cover. Piezometer connections for all four gages were identical. All were located at summits in the line where air valves had been installed. These valves were, in essentials, rubber balls held against seats in 4-in. openings by the pressure in the pipe line. The housings, roughly spherical, about 18 in. in diameter, were set over the concrete pipe, connected by short nipples 4 in. in diameter to plates cast in the concrete pipe. Near the bottom of each housing shell was a small hydrant cock. These cocks gave easy access to pressure head within the concrete pipe. The pressure tubing leading to the manometers was slipped over the end of the hydrant cock and securely wired to make a watertight connection. When the cock was turned on, the pressure head, without velocity influence, was transmitted from the concrete pipe to the manometer.

Both gage glasses of each of the four manometers were carried into the scheme of levels; the graduated glasses being read directly, to thousandths of a foot, with an engineer's level. Base levels are brought up from the nearest benchmark. These benchmarks are well established. They had also been checked against U.S.G.S. precise levels. The readings to .001 ft. are academic rather than accurate when considered in connection with losses of head between two manometers several miles apart but they are necessary for the computations for the height of the mercury column on any one manometer, a differential reading of mercury column to the extent of 0.001 ft. being equal to a water column of 0.014 ft. (nearly).

Test Reaches—Water entering this pipe line (conduit 10) falls over a weir at Kassler filters near Sta. 0, flowing down a grade approximating that of Platte River until the pipe fills and comes under pressure—this point varying with the flow. Gage 1 was connected with the air valve at Sta. 74 + 01.0, this being the point nearest the filter plant where the concrete pipe would be under pressure for the lowest flow to be tested. A water column for this flow would have been about 10 ft. above the top of the pipe. Gage 2 was placed on the air valve at Sta. 259 + 99.0. Thus reach 1, between gages 1 and 2, on the old (1921) pipe, was 18,598 ft. or 3.5 miles long. The new pipe (1924) commenced just below gage 2. The nearest air valve was located on the reducer at a 48-in. valve set in the 54-in. line. A connection at this point was not desirable for two reasons, (1) the disturbance in flow due to the valve and (2) the correction necessary due to change in velocity head since there was a drop in the hydraulic gradient as the water was speeded up to pass through a 48-in. contraction. Gage 3, therefore, was placed on the air valve at Sta. 317 + 34.6, a distance of 5,774 ft. below gage 2. This does not check the station numbers as an equality added 38 ft. to the line. Reach 2 between gages 2 and 3 was not computed separately. Gage 4 was placed on the air valve at Sta. 456 + 36.8, a distance of 13,902 ft. (2.6 miles) below gage 3. Reach 3

ELEMENTS OF EXPERIMENTS FOR THE DETERMINATION OF FRICTION LOSSES IN CONDUIT NO. 10, DENVER, COLO.

Retardation factors in various formulas are also given. The conduit is a reinforced-concrete pipe, running full and under pressure.

Reach	Inside Dia., In.	Alignment	Length Tested Ft.	Quantity (Q) M.G.D.	Quantity (Q) Sec.-Ft.	Velocity (V) Ft. per Sec.	Elevation of Gradient in Feet Upper Gage	Elevation of Gradient in Feet Lower Gage	Loss of Elevation in Feet Between Gages	Loss of Elevation in Feet Per 1,000 Ft.	Coefficients of Retardation Scobey *Cs*	Hazen-Williams *Cw*	Chezy *C*	Kutter *n*	Weisbach *f*	Temperature, Deg. C. Air	Temperature, Deg. C. Water
1	54	Nearly straight	18,598	26.46	40.95	2.58	292.522	287.550	4.972	0.2673	0.412	154	149	0.0105	0.0116	26	20
3	54	Sinuous vertically	13,902	26.46	40.95	2.58	285.673	281.062	4.611	0.3317	0.370	138	134	0.0116	0.0144	28	20
2+3	54	Sinuous vertically: Includes one 48 in. valve	19,676	26.46	40.95	2.58	287.550	281.062	6.488	0.3297	0.371	138	134	0.0115	0.0144	28	20
All	54	Combined	38,274	26.46	40.95	2.58	292.522	281.062	11.460	0.2994	0.390	146	141	0.0110	0.0130	27	20
1	54	Nearly straight	18,598	35.96	55.62	3.50	305.366	295.991	9.375	0.5041	0.407	148	147	0.0107	0.0119	29	20
3	54	Sinuous vertically	13,902	35.96	55.62	3.50	292.748	285.338	7.410	0.5330	0.396	145	143	0.0109	0.0126	30	20
2+3	54	Sinuous vertically	19,676	35.96	55.62	3.50	295.991	285.338	10.653	0.5414	0.393	143	142	0.0110	0.0128	30	20
All	54	Combined	38,274	35.96	55.62	3.50	305.366	285.338	20.028	0.5233	0.400	146	144	0.0109	0.0124	30	20

is between gages 3 and 4. Thus gages 1 and 2 define the ends of a reach on the old line and gages 3 and 4 a reach on the new line. Between gages 2 and 4 the line is practically all new but contains one 48-in. valve. Between gages 1 and 4 is a reach 38,274 ft. (7.2 miles) long approximately equally divided between old and new line.

The Tests—Two flows were tested, one day apart. The first at 26.5 m.g.d. gave a velocity of 2.58 ft. per sec. in the pipe and the second at 35.96 m.g.d., which was the maximum that could be cared for at this time. This gave a velocity of 3.50 ft. per sec. The ultimate maximum capacity between Kassler and Capitol Hill reservoir will be about 50 m.g.d. daily.

The regimen of flow was well established for each run. Simultaneous readings were made on all four gages, every two minutes for a period of one hour. The gages were blown out every few readings to remove any air bubbles that had accumulated in the pressure-tube line. The average elevation of the hydraulic gradient at each gage was afterward computed by converting the mercury differential into the equivalent water column and adding this water column to the elevation of the average reading of the low leg of the mercury U-tube. The loss of elevation in the hydraulic gradient, for a pipe of uniform diameter, is the loss of head due to retardation of flow, ordinarily termed "friction."

The quantity of flow was determined by Pitot tube measurements, made simultaneously with the gage readings. These measurements were made by traverses in two directions 90 deg. apart, across the 36-in. cast-iron pipe into which the new 54-in. concrete pipe now discharges. The directions of traverse were not taken in the vertical and horizontal diameters but across a symetrical X regarding the pipe section as a clock dial, from 10.30 to 4.30 and from 1.30 to 7.30. This saved excavation of earth and more truly reflected velocity elements. The two curves were quite similar even though there was a pair of elbows but 80 ft. above the meter station—the first elbow leading out of the new 54-in. concrete pipe and the second elbow turning back parallel to the concrete pipe in the 36-in. cast-iron pipe.

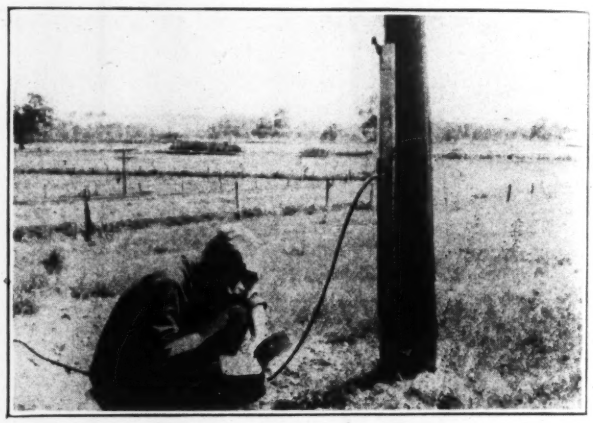
This measurement plan was the best of three possibilities: (1) The weir at the pipe intake, which had faulty contractions and a very turbulent approach as the water surged out of the filter reservoir into the weir chamber, further complicated by the addition of another small unmeasured flow; (2) The flow resulting from adding together the flow in two Venturi meters and deducting the flow in a third; and (3) the Pitot tube measurements finally used. However, the pitometer gagings checked the Venturi figures as outlined under 2 above.

The elements of the tests, together with the computed coefficients of retardation, are given in the accompanying table, a study of which shows:

1. The 1921 pipe, after four years' service, has a lower friction factor than does the 1924 pipe after six months' service. It is true that the 1924 pipe is more sinuous but not sufficiently to account for the difference. This is probably due to a very thin but very slick coat of slime, noticed in the 1921 pipe when I was inside it in November, 1924. It was nearly impossible to walk, where the pipe remained wet, due to this slime. When dry, a mere cloud in the usual white-gray surface was noticed.

2. The second test, at a velocity of 3.5 ft. per sec. shows less difference than does the first test. In my opinion this run gives the better indication. In nearly all experimental work of this nature the tests at the higher velocities are better than those at low velocities. The necessary loss of head between gages becomes great enough to overshadow experimental errors that are ever-present in greater or less degree.

3. The factors found agree within all reason with



GAGE 3, A TYPICAL MERCURY MANOMETER
The long rubber pressure tubing connects through manhole with 54-in. concrete pipe. Gage blown through tubing around air-vent pipe, against which gage was plumbed.

those determined for the same size pipe at Tulsa, Okla., in November, 1924 (see *Engineering News-Record*, May 28, 1825, p. 897). They all indicate that the Scobey formula, with a coefficient C_s of 0.370, as originally recommended for the best of concrete pipe, is very conservative. This formula is $V = C_s H^{0.5} d^{0.625}$, where V is velocity in ft. per sec.; H is loss of head in ft. per 1,000 ft. of pipe and d is internal diameter in inches. The interior surface of concrete pipe such as these can be more assuredly repeated than can concrete surfaces cast in the field. For this reason a smaller factor of safety, in computing the capacity of a line, may be allowed. The units in this line were cast on a tolerance of $\frac{1}{16}$ in. in diameters, from the nominal diameter of 54 in. Measurements on the one joint remaining from construction verify this. A better verification is found in the measured diameters of units on the Tulsa line. The average area of ten units, measured at random, was computed to four significant figures before there was any variation with the area of the nominal pipe.

These tests were carried out by the Division of Agricultural Engineering, U. S. Department of Agriculture, in co-operation with the Board of Water Commissioners of the city of Denver. The writer was in direct charge of the tests, installed the gages and took readings on gage 2. He also drove between gages and assured himself of the accuracy of all gage readings Burton Lowther, chief engineer for the Denver municipal water-works, arranged for the maintenance of a constant flow before and during tests, for measurements by pitometer of the discharge, and delegated engineers and instrumentmen as gage readers, after they had carried elevations from established benchmarks into the graduated gage glasses.

Brick Wall Underpinned to Remove Proscenium Arch

Fifty-Foot Steel Girder Inserted Over 30-ft. Arch to Carry Fly-Loft Wall Rising 35 ft. Above Theater Proscenium

By A. H. Taylor
Engineer, Cleveland, Ohio

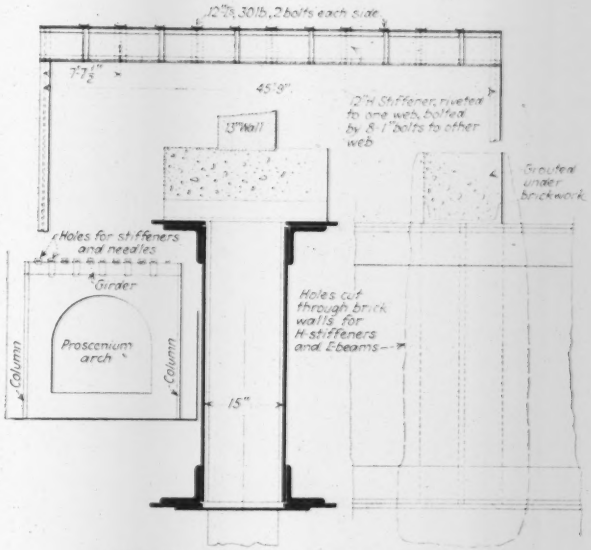
An interesting problem in underpinning occurred in remodeling the Star Theater of Cleveland into a motion picture house. To increase the seating capacity of the theater it was necessary to remove the old proscenium arch which stood forward 30 ft. from the rear wall of the building. The arch was a full semi-circle with a clear span of 30 ft. The ring was nine courses of row-locks bonded together both horizontally and vertically. The width of ring was 21 in., while the fly-loft wall above was 13 in. wide. The brickwork was in good condition. The crown of the arch was about 28 ft. above the stage floor level and about 35 ft. from the basement floor. Above the arch the wall extended an additional height of about 35 ft. The accompanying drawings indicate the arch and wall and also the other details of structure and construction hereinafter referred to.

The design called for a girder with a span of 45 ft. 9 in. carried on steel columns to support this wall and permit the removal of the proscenium arch as well as all the rest of the wall under the new girder. The usual method of performing this would have been to needle the wall at the proper height and shore it up, then remove the arch and the balance of the wall, then erect the steel and then transfer the weight of the wall from the needle beams to the new girder. Inasmuch as working space was very restricted and would have been a great deal more so after a number of shores had been distributed under the wall, the writer, who was in direct charge of the work, developed an idea of dispensing with the temporary shoring and using the new structural framing to carry the load directly.

As originally designed, the girder had a single-web plate. With the new scheme this girder was made up in two parts, each part consisting of a web plate, one top flange angle, one bottom flange angle and a small cover plate top and bottom as shown by the drawing. The girder was so designed in order that the two parts could be erected separately, one on each side of the wall to be underpinned. The method of procedure was as follows:

First the arch was shored with a fan-shaped series of props all meeting at a point level with the spring line. The horizontal members and the vertical member were one length of 3x12-in. spruce timbers which were taken from the old stage floor. The horizontal members were bolted through the walls at each end to take care of a possible thrust which might occur during the demolition of the arch. As an extra precaution, six parts of ¾-in. cable were used as a tension member between the ends of the arch. The pull of these cables was distributed over the brickwork at each end by two pieces of rail about 5 ft. long. After threading the cable through the brickwork and clipping the ends together it was drawn up tight by means of twisters.

Portions of the wall at each side at the basement floor level were then removed and the concrete footings for the steel supporting columns were poured. Slots were then cut in the wall a little larger than the steel columns. These slots were cut entirely through the wall and to the full height of the columns. While the slots were being cut for the columns, holes were also being cut for the H-spreaders as shown in the drawing. These spreaders really operated as stiffeners to carry the weight of the wall to the girder webs. A short section of the 12-in. channel was placed over each of these stiffeners and also at intermediate points: These intermediate needles required only a small hole to be cut through the brick wall as no stiffeners occurred under them. The structural steel was erected without difficulty. After the columns were in place, one-half of the girder was erected. Then the H-stiffeners were



SKETCHES OF UNDERPINNING DETAILS IN REMOVING PROSCENIUM ARCH

temporarily bolted in place after which the other half of the girder was erected. The stiffeners were then bolted up permanently by means of bolts running completely through both webs.

After the top channels were in place, forms were built around the channels so that the actual underpinning could be done. These forms were made a little higher than the tops of the holes so that the grout would flow up under all parts of the brickwork. The concrete needle beams were poured on Saturday morning, using alumina cement, and on Monday the old proscenium wall was taken down. This was effected without incident, all brickwork being removed down to the arch ring and then successive row-lock courses of the ring itself removed. All brickwork was removed to the top of the girder, after which the bottom plates of the girder were placed.

All work in preparing the wall to receive the structural steel as well as the demolition of the arch was performed from a scaffold suspended from the ceiling joists thus minimizing the danger of personal injury.

Survey of Magnetic Bearings in Mid-West

The United States Coast and Geodetic Survey will conduct a survey to check magnetic bearings in the Mid-West. R. R. Bodle, magnetic observer for the Coast and Geodetic Survey, Washington, D. C., will conduct the survey from St. Paul, Minn., to Tucson, Ariz.

New Bay City (Mich.) Water-Works Displaces Two Old Plants

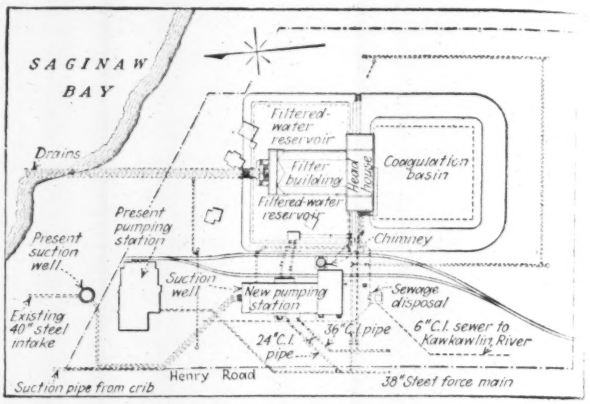
Pumping Station and Filters on Saginaw Bay 3.5 Miles from City—New Pipe Lines Laid—Hydraulic Jump Utilized

By J. W. Ellms
Consulting Engineer, Cleveland, Ohio

BAY CITY, Mich., has recently completed a single new $2,000,000 water-works system to replace the two old plants serving the East and West Sides respectively. No pipe mains crossed the Saginaw River connecting the two water systems. The supply for the East Side was drawn from Saginaw Bay 2.5 miles east of the mouth of the river, but there was an emergency intake in the Saginaw River opposite the East Side pumping station, which was located in the settled portion of the city. Owing to the dilapidated condition of the 36-in. wood-stave pipe suction line from the bay, the emergency intake was frequently used. A grossly-polluted water unfit for drinking purposes was, in consequence, served from this station for many years. The supply for the west side of the city also came from Saginaw Bay, but about 2.75 miles west of the mouth of the Saginaw River. A pumping station located on the shore of the bay forced water to the distribution system on the west side of the river. This water was much less subject to contamination by the discharge of the polluted Saginaw River water and furnished a fairly satisfactory supply after chlorination.

The need for a sufficient quantity of a safe and potable water became so urgent that the city authorities decided to combine the two systems into one, build a new intake crib and conduit, and a pumping station and filter plant, and to abandon the two old pumping stations. The new intake crib was located, from surveys as to quality in Saginaw Bay, 4,000 ft. from shore and not far from the old West Side pumping station intake. The new intake crib was built of timber on shore, floated to place, filled with rock, and connected by a 48-in. lock-bar steel pipe with the shore shaft and suction well located in the pumping station. The new intake pipe is cross-connected with the old one a short distance north of the new suction well. From this well the water is pumped to the new filter plant, at the east side of the new pumping station. After filtration, the water returns to the pumping station and is forced a distance of about 3.5 miles by the high-service pumps through two pipe lines, one consisting of a 24-in. and 20-in. cast-iron pipe, and the other of a new 38-in. riveted-steel pipe. These mains feed the distribution system on both sides of the Saginaw River, directly on the West Side and by under-river crossings to the East Side. The crossings, with approaches, are 5,800 ft. long, one 26 and the other 32 in. in diameter, both of riveted steel.

Pumping Plant—The pumps, with one exception, are all steam driven, supplied by three 275-hp. water-tube boilers, designed for 180 lb. steam pressure and a superheat of 100 deg. F. Multiple-retort, underfeed stokers draw coal from a 200-ton overhead steel bunker. A hand-operated hopper weighs and conveys the coal from the bunkers to the stokers. A track hopper, apron feeder, coal crusher and pivoted bucket conveyor receive, crush and convey the coal to the bunkers.

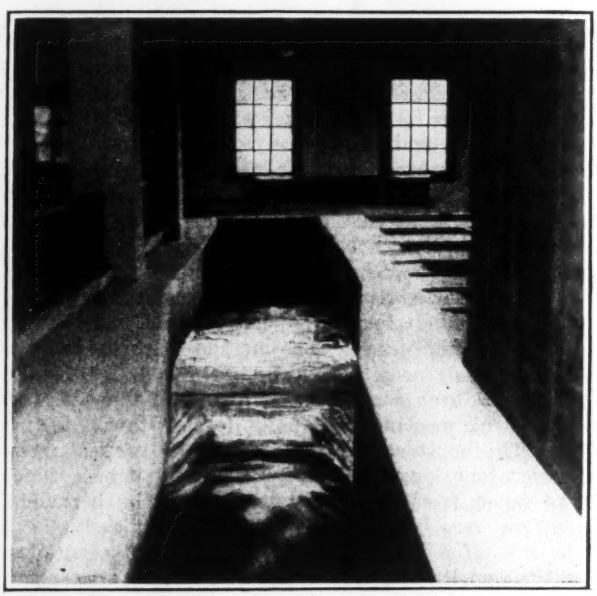


LAYOUT OF BAY CITY FILTER PLANT AND PUMPING STATION

The unloading room alongside the boiler room enables coal to be transferred from railroad cars to the bunkers without exposure to the weather. A section of the coal bunker lined with tile provides a storage bin for ashes, and is served by the same conveyor system handling the coal.

Of the three low-lift centrifugal pumps which supply the filter plant, two are 10-m.g.d. steam-turbine-driven and one is a 5-m.g.d. electrically driven pump. The high-service pumps, which pump directly into the distribution system, consist of a new 11-m.g.d. cross-compound pump, and three old 5-m.g.d. pumps taken from the old pumping stations.

Filter Plant—The filter plant consists of two hydraulic-jump mixing flumes, two baffled coagulation basins, ten 2-m.g.d. filter units and one 4.8-m.g. filtered-



HYDRAULIC JUMP CHANNEL FOR MIXING COAGULANT WITH INCOMING WATER

water reservoir divided into equal parts. A single superstructure with an area of nearly 21,000 sq.ft. houses the plant, the head house, offices, etc., being three stories high and the filter house one story.

Water from the low-service pumps enters the head house through a 42-in. cast-iron pipe provided with a

Venturi meter. It rises through a well at the center of the building and overflows a weir to a chamber common to the entrance throats of two hydraulic-jump mixing flumes, each of which has a normal rated capacity of 12 m.g.d. The chemical solution is applied to the entering water just after it leaves the rising well and a few feet from the throat of the mixing flumes. The hydraulic-jump principle of mixing, developed by the writer, is utilized in effecting a thorough mixing of the coagulating chemical and the raw water. The flumes may be used either separately or combined. Each is approximately 35 ft. in length, expanding from a throat width of 4 ft. at the entrance end to a width of 8 ft. at the lower or exit end. A flaring flume tends to stabilize the location of the jump. The sloping portion of the flume is 20 ft. long and to obtain a velocity of 10 to 12 ft. has a drop of 3 ft. in 20 ft., a portion of which head is recovered due to the jump taking place on the sloping section. After passing the jump the water flows through a conduit (baffled if desired, but not yet found necessary) to the coagulation basins.

Two covered coagulation basins just south of the head house are each 89x192 ft. in plan and 21 ft. deep. Each basin is divided into two parts by a single round-the-end baffle wall. They each hold 2 m.g.d. and permit a theoretical period of detention of nearly five hours at a maximum capacity of 20 m.g.d. Original designs were for a 24-m.g.d. capacity and retention of 4 hours since at times the water is quite turbid. Only 20 m.g.d. capacity was built at present so there is excess detention capacity. The water leaves the basins over a skimming weir and enters a 48-in. steel influent pipe, which is diminished in size to a diameter of 42 in. near the middle of the pipe gallery. From this pipe line the filters are fed with the treated and settled water.

Filters—Each of the ten 2-m.g.d. filter tanks is 28.5x28 ft. inside measurements. Each tank contains 62 3½-in. diameter laterals of extra strong wrought-iron pipe, designed for a high-velocity wash. Adjustable gutter edges permit variation of the rate. Each pipe lateral is 12.25 ft. long, and is perforated with 24 ½-in. diameter holes, 6¼ in. c. to c. The laterals enter a mainfold laid underneath the center wash-water gutter. The one manifold, therefore, serves all the laterals in the filter tank. This arrangement avoids the necessity for a manifold through the center of each half of the tank, and yet provides uniform distribution of wash-water in the washing process. The design of the lateral system relative to spacing and size of pipe and perforations was based on Harry N. Jenks' work at Sacramento (see *Engineering News-Record*, Jan. 27, 1921, p. 162) and the writer's experiments (unpublished) on the relation of the cross-sectional area of the manifold to the sum of the cross-sectional areas of the laterals. The writer's experiments checked those of Mr. Jenks and extended his results. The ratio of 2 to 1 is correct for the most uniform distribution.

The 20 in. of graded gravel in the bottom of each tank ranges from 2½ to ⅛ in. in approximate diameter. The 30 in. of sand has an effective size of 0.36 mm., and a uniformity coefficient of 1.74. Steel gutters with an adjustable weir are built into each tank, the distance between gutter edges being 4 ft. 3½ inches.

PUMPING STATION (LEFT) AND FILTER PLANT HEAD HOUSE (RIGHT)
Buildings are of dark red rough texture brick laid with Flemish bond and trimmed with cut sandstone. The interior has light colored face brick and terrazzo floors.

Wash-water is supplied from three steel tanks located on the second floor of the head house. They have a combined capacity of 100,000 gal. and are filled through a pipe line connected to the distribution header outside of the pumping station, the flow into the tanks being controlled by an altitude valve. Provision has been made for a pump to fill these tanks when the draft on the main feeder lines of the distribution system becomes too heavy. A Venturi meter in the wash-water line registers the quantity of water drawn for washing filters.

The filtered-water reservoirs, coagulation basins and wash-water tanks are each provided with alarm-bell and light-signal systems, so that the filter plant operators may be kept informed of high and low water conditions. A table in the lobby of the head house furnishes a place for indicating and recording level gages. Similar gages and bell and light-signal systems are installed in the pumping station to show the operators of the pumps the water level conditions in the coagulation basin and filtered-water reservoirs.

The Frazier, Ellms, Sheal Co. of Cleveland, Ohio, designed and supervised all of the improvements described above, James W. Frazier having general supervision during the construction period. P. O. McQueen, George Chessel and C. B. Pierce were resident engineers. The work was initiated, all 21 contracts let and most of the construction done under William H. Reid, city manager, succeeded by W. E. Baumgardner, present city manager.

"English for Engineers"? Never!

Some Reflections of One Who Teaches English But Not "Engineering English" to Engineering Students

By C. Ralph Bennett
Department of English, College of Engineering and Architecture, University of Minnesota

IT'S great sport, teaching English to these freshmen engineers. I have done it for several years now, in the College of Engineering of one of our best-known mid-western universities. It was a new sort of teaching for me. I wondered how I should like it. Now I know. Nothing could be more fascinating.

I do not teach "English for Engineers." I have nothing to do with "Engineering English." I do not know what those things are. I do not believe they exist. It is not sensible to talk about Veterinarian Plane Geometry. But that is no more absurd than what we have heard for years. English is English. It is exactly the same no matter where it is taught, no matter to whom it is taught, or when. A difference in buildings, a difference in students, a slightly special application here, a slightly different emphasis there, perhaps—but it is all the same in purpose. Its object is to teach students to express themselves on paper. As long as it tries to create that ability to write down thoughts in the students to whom it is taught, it has accomplished its purpose. The young engineer does not need a special course. He does not want one.

Freshmen engineers are pretty much like all other freshmen—I think they are better—but there are two differences, important differences for us who teach English to them. They know very definitely what they want. And they have inherited a tradition throughout the years, carefully fostered, lovingly nourished. Each one of them enters college thinking that he has hidden in his soul one great hatred. He thinks he hates English.

Note that—he thinks he *hates* English. That is a splendid sign. I like it. There is mental activity where there is hate. There is material to work on. That's the fine thing about these boys—they have violent reactions. They are no spineless jellyfish wriggling their way through college.

The Question Why—Their hate is easily explained. Why, after all, should an engineer have to take an English course? What use will he ever have for it? Mathematics and shop and drawing and surveying—those are good. They are the right stuff, the very fundamentals. But English! Abomination!

That is our problem. Every year we have it anew, when fresh groups of these alert youngsters flock to us from the farms and villages and cities of this Middle West, their minds filled with visions of wide flung bridges and towering dams. They have come to us for an education. With most of them that coming has meant sacrifice, sometimes great sacrifice. They are here to work, to use every moment. They have only one aim, to become good engineers. Courses must count with them; time is limited. They have no time for fluff. English seems fluff. These boys have been through high school.

They aren't backward in telling us what they want, for they are delightfully frank. I have often seen unexpressed groans on their faces during those first restless fall days. I have read their themes, hundreds of them. They tell me they don't want English.

And there we are.

Of course, we English teachers never admit it. English is a required course. And so we set to work.

I know these freshmen hate to write themes. And so I make them write me many of them. The boys sweat for hours over these productions. They heap curses upon my head. But they give me results.

For most of them, theme writing in high school has meant only hard work, a lifeless reproduction of uninteresting facts retailed for some teacher who was shocked if a student dared to have his own ideas. I want ideas. I become a bit fantastic. I try my best to create some interest.

In all my experience, I have never given a so-called "technical subject." I have never asked the boys to tell me what they think someone else has thought about something in which they only think they are interested. I have tried to stimulate their imagination, the imagination which they have but have never known, simply because they have never been allowed to give it a chance. They will need that imagination if they are to become good engineers.

Imagination—I read them Lord Dunsany's fantastic stories—I steep them in them. At first the boys think I am crazy. Some of them never lose that idea—but the seed takes root. Something new is unfolding itself to them. Here are the very commonplaces which they have known all their lives, the very commonplaces which shut out all else from so many of us. But what a difference. An ash heap has become fraught with beauty and pathos, and the wind, that very wind which has run with them down hill, has become wonder laden.

Imagination begins to stir in them. I beam with happiness. My theme subjects become more fantastic, more far flung. I explain less and less what I want, and leave it to the boys. I tell them to let their imaginations run riot. Improvement begins.

From the crudest of efforts, they begin to grope their way, more and more sure-footedly. I find a spark where before were but cold ashes. Amazingly soon nearly every one of these boys will write me a theme worth reading if I merely give the classes "When the Gods Slept." They will not all be good themes. But every freshman will have made his attempt; every theme will have at least some interest.

There is nothing extraordinary in this. It seems a bit unusual, but it is not. It seems strange, because it is so very sensible. All that has happened is that the most obvious method of getting these freshmen to write has been lost sight of in this balderdash about "Engineering English." If there is one group on God's earth which has poetry in its soul, it is the engineers. Poetry is born with them. They are always seeing visions and dreaming dreams. Their minds need to reach out and grope. They need to make things of their own.

This may sound foolish. It isn't. These boys have lain on their backs on these green northwestern hills and have dreamed their futures in the sky. They have seen their dreams in concrete, and in iron and steel machines. They have listened to the stories of their ancestors, and have thrilled at Viking sagas. They have the imagination. They are seeking for expression, though they would never admit it.

I have found the method successful. I have had from freshmen what I consider, what I shall always consider, astounding imaginative pieces, written by students who came to me with the idea of there being nothing new under the sun—simply because they had never been taught to see it. Bits of whimsy, beautiful little things, delicate as gossamer, have come from some of them who would stoutly maintain to you that they are "hard-boiled engineers." Why, one of them even told me last year that he has a love for poetry, that he reads it when his friends have left him and he is alone. He was ashamed. He thought they would laugh at him if they knew. I know they wouldn't have laughed. He was not the only one who was reading poetry in private.

It all seems a bit unreal, this that I have been saying. Is it too much to believe? I should have thought so once. But I know what has been given me. Here is a bit, a little theme, which I choose from the little weekly publication we have issued every year for the students, a little sheet made up each week of the best work handed to us during that week. The boy who wrote it is now a sophomore, a typical engineer. He had never before had a real opportunity for expressing himself:

SHADOWS

Beyond that great dividing line beyond which the pines and the beasts rule, and men fear to go, there lies the land where shadows of great pines lie quivering and muttering and swearing vengeance. Small wild things seek hiding and protection in the depth of these shadows.

It was not always so. Once the shadows of these pines were their equals; standing erect, they stood side by side with the real trees. When the pines sang and tossed in the cold night air, then the shadows sang silently and tossed. When the shadows were silently quiet, or murmuring, then the pines were either still or sighing sadly.

Then one bitter night all the shadows decided that they would no longer follow the example of the pines, but would free themselves and move or sing or weep, as they pleased.

As the wolf howled twelve long howls on that fateful night, the battle, of which the pines still whisper as the wolf howls at midnight, started. It must have been terrible. The shadows and the pines beat each other with all their might. As they struck and beat and rallied and struck again, there was a deafening silent clamor. But the trees' boughs were longer and harder, and when the wolf howled the next hour gone, every shadow was lying beaten and breathless at the feet of the trees.

Now the wild things walk on the shadows, and the shadows only quiver and mutter and swear vengeance.

There is a little bit of beauty, or I am no judge. That boy wove it out of his own experience. If he will not be a better engineer for having found that imagination which was trying to express itself, I shall be disappointed, deeply.

He is not the exception. He had caught the spirit, I grant, a bit better than some of the others. But all of his classmates were wandering, too, where their imaginations were leading them, and most of them wandered amazingly well. They were finding that they had ideas they had never discovered. Even the poor ones were trying to leap with the rest. Trying is all I could ask.

Do you wonder that our little mimeographed paper, their paper, meant much to them—that they vied with each other to write themes which might be included in it, even bet their friends that they could?

Now these freshmen have finished their English work. They have suffered with the grammar upon which we spent months, months because they knew nothing of English grammar when they came to us. I know that we spent none too much time upon it. It is the foundation of all written expression. Whatever else these youngsters carry away with them, I feel that they will at least know how to use the English language properly.

Bit by bit a new world opened for them. They ranged over the literature of the world with me, and found it good, even interesting. They never thought before that real men wrote "literature." Literature had always been a matter of calfskin in dusty parlor bookcases for them. But those old Greeks weren't so old-fashioned. That fellow Homer could tell a story. Cervantes knew his stuff. Dante was beautifully horrible. And "Les Miserables"—well, that's good enough to read over again.

We did not have time in that one short year for much—only a taste here and there. But we sampled good fruit. All we can hope is that our boys will keep on reading. Now they know the way, just a tiny bit of the path. They have found red blood in great works. They have dreamed a bit and sighed a bit, and maybe—God forbid—cried a bit. They have discovered, if I have done my work, that there are living books, and that all good things have not come out of England.

Many of these students come back to me, after they have finished their required work. They can speak more freely now. They come into my office to see me, to tell me what they have read, or seen, or thought, or just to talk. They will be free from "culture" there.

They come back for more work with us. They want us to give them advanced courses in writing, in literature. They keep the reading lists which we gave them as freshmen, and wear them thin. One of them is likely to rush in at any time to tell us that this chap Hudson's "Green Mansions" is the real thing, or that "Vanity Fair" is not worth a damn. We aren't surprised any more.

I have sounded enthusiastic about this work. I have meant to be. It has more possibilities than we have yet imagined. We have blundered for years; we can only hope now that we are on the right track.

Is it not more sensible as a method than the old? These freshmen do not want to write about their engineering work. They are born makers; we have tried to give them themes to make. We have tried to teach them to express themselves vigorously, effectively, carefully, by the written word. We have deluged them with grammar, with principles they can understand and use. We have tried to give them life and interest.

And more than all, perhaps, we have taught them that they have more ideas than they ever suspected. They have discovered with us. We have been a bit fantastic together, that we might be all the more sane alone. We have actually become interested.

I have never tried merely to amuse these boys. I have never worked solely to entertain them. I have asked only that they do their work, and do it well. Both of us have remembered that English is English, and that English in an engineering college is English, too.

Fine lads, these freshmen engineers! They like even English. But I hope they never admit it.

Rigid Frames in Concrete Bridge Construction

Frame Type of Bridge Is Economical, Has Great Ultimate Load Capacity, and Is Freely Adaptable to Architectural Demands—Examples of Its Use in Parkway Bridges

By Arthur G. Hayden

Designing Engineer, Westchester County Park Commission, Bronxville, N. Y.; formerly Designing Engineer, Bronx Parkway Commission

IN THE following article the writer will attempt to show the application of rigid-frame construction to concrete bridges. Structures of this type have been used with marked success by the Bronx Parkway Commission (now out of existence) and are now being used by the Westchester County Park Commission. The

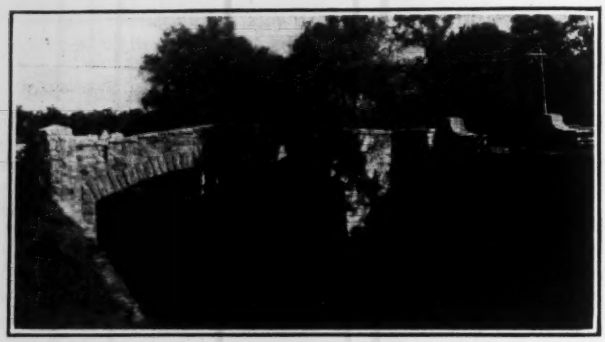


FIG. 1—A STONE-FACED FRAME BRIDGE
Palmer Ave. Undercrossing, Bronxville, N. Y. Architect, Charles W. Stoughton. Spans nearly twice as long have been designed in rigid-frame construction.

advantages of the type are: *first*, inherent economy; *second*, great ultmate load-capacity as compared with traditional types; and *third*, remarkably flexible adaptability to architectural forms. Because of these advantages the type merits wide use; the methods of attack set forth may facilitate such use.

General Considerations—The case of statically indeterminate structures—to which class the rigid frame belongs—versus structures of common type was discussed by Prof. George E. Beggs before the American Concrete Institute, three years ago (*Proceedings*, 1923), in very effective manner. To quote him:

> "Comparative studies of a number of statically determinate structures and indeterminate rigidly connected frames show that frames which are rigidly connected member to member support their loads with minimum effort. The deflection under loads decreases as the rigidity of the structure increases, the external work done by the loads is correspondingly less, the corresponding internal elastic energy to be stored up by the stresses is equally reduced, whence smaller areas, saving of material and reduction of cost of the structure follow. The work that a structure must do in supporting its load is not only divided among all members of a rigidly connected structure, but the total work to be done is less by reason of the rigidity. The economy of an elastic continuous structure is well illustrated in the description given in *Engineering News-Record*, Jan. 11, 1923, p. 73, of a continuous-frame design for the highway bridges over the Bronx Parkway roads. The estimated overall saving as compared with a true arch design is given as $5,000 per structure.

Inherent Economy—Fig. 2 shows two photographs of small models constructed of splines and loaded with leaden weights to illustrate the difference in action between a statically determinate structure and an indeterminate frame of equal dimensions. The difference in deflection is noticeable. The external work which must be absorbed by the structure is 2½ times as great in the first case as in the second. Moreover, in the latter, the columns share in absorbing the work. The greater efficiency of this structure is evident.

Incidental Savings—The inherent economy of the rigid frame is not its only economy, however. The beam bridge requires a greater floor depth, and necessitates raising the grade of the roadway over the structure (Fig. 3), very often involving longer approaches and considerably greater quantities in the approach embankments. This comparison has been made for several overcrossing and undercrossing structures for the Bronx Parkway Commission and Westchester County Park Commission, and the rigid-frame design resulted in substantial savings.

The arch as compared with the rigid frame requires either greater rise or heavy abutments, which latter involve heavy excavation. Complete fixity at the springing of a concrete arch can only be obtained at the expense of massive abutments, most of the material in which represents the price paid for an increase in end restraint from partial to complete fixity, obviously out of proportion to the advantage gained. The expediency of cutting down the abutment to the comparatively thin leg of the frame is evident. Further,

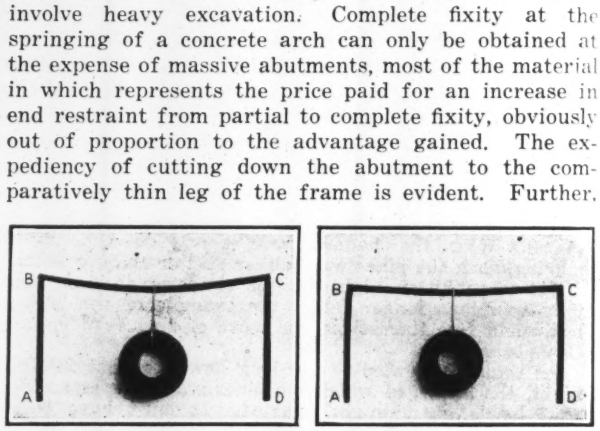


FIG. 2—BEAM AND RIGID FRAME UNDER LOAD
The two structures have equal dimensions and loading, but in one the columns and beams are separate while in the other they are integral. Note the difference in deflection.

the horizontal earth pressure of the backfill may be utilized at no additional expense, and thus more closely approximate the condition of the fixed-end arch.

Some Specific Cases—The first rigid-frame bridge designed for the Bronx Parkway Commission by the writer was the Swain St. undercrossing (*Engineering*

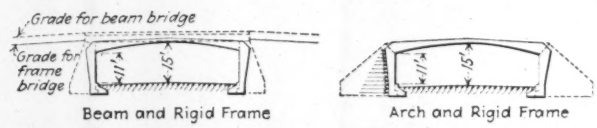


FIG. 3—FRAME TYPE COMPARED WITH BEAM AND ARCH
At left, saving of grade and dimensions over beam type. At right, saving in masonry volume over arch. The pressure of the backfill behind the vertical leg is not utilized by the arch.

News Record, Jan. 11, 1923, p. 73). Three comparative designs were made for this bridge: a slab-and-beam design, an arch design, and finally the rigid-frame design. The grade of the driveway being fixed by local conditions and minimum clearances being given, the slab-and-beam design would have necessitated raising the grade of Swain St. over the structure. The

arch design would have required heavy abutments and expensive excavation. Both objections were avoided by the frame bridge, since the distance from the underside of the soffit to crown of road above was less than 18 in. and there were no heavy abutments to be built. The clear span of this bridge is 41 ft. and its total width 56 ft.; the saving in cost over the arch or beam was about $5,000.

Recent comparative designs for a highway bridge of 70-ft. clear span and total width 40 ft. show that a structure of the frame type can be built for about $1,000 less than an ordinary, purely utilitarian, plate-girder bridge.

Five structures of the Swain St. or solid-slab type

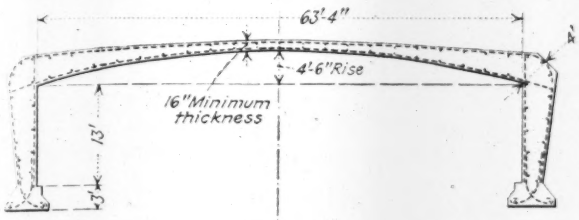
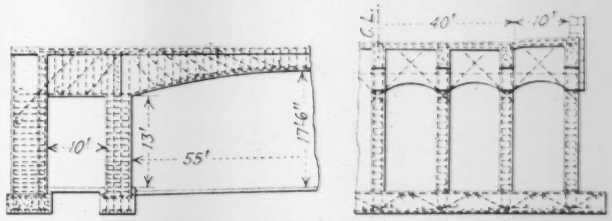


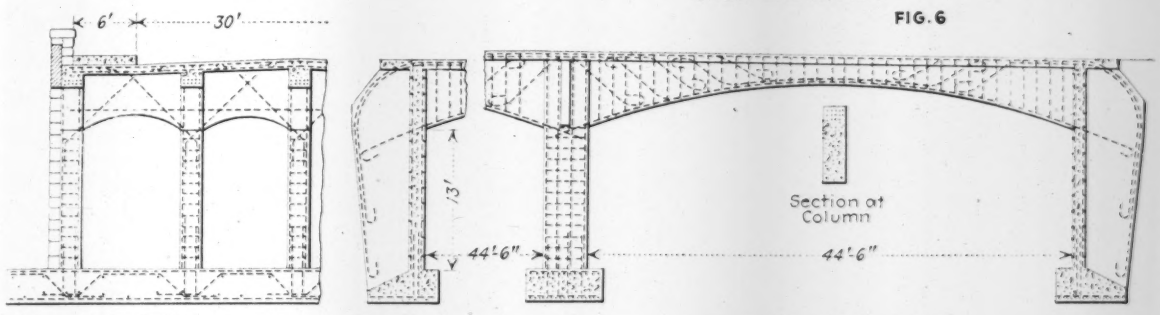
FIG. 4



Elevation of Intermediate Girder and Columns

Section at Crown

FIG. 6



Section

FIG. 5

Sectional Elevation

FIGS. 4 TO 6—STRUCTURAL ARRANGEMENT OF DIFFERENT FORMS OF RIGID-FRAME BRIDGE
Fig. 4—Solid-Slab Type. Fig. 5—Ribbed Type as Applied to a Two-Span Structure.
Fig. 6—Three-Span Bridge of Ribbed Construction

are in service on the Bronx Parkway and one other is under construction. Two have been built for the Westchester County Park Commission in Yonkers, and several others are under contract or being designed, up to 70-ft. clear span. Ribbed frame bridges are being designed up to 100-ft. clear span.

A Strength Test—Aside from economic advantage, the rigid-frame bridge possesses, as does the fixed arch, great inherent strength as measured by its ultimate capacity. If extraordinary loads should overstress one part of the structure, the burden of internal work is transferred to other parts of the structure, and collapse due to the overstress need not be feared. This was well illustrated in the tests to destruction of two small models of the Swain St. bridge.

Two model reinforced-concrete frames were built, with 10-ft. span, 3 ft. wide, crown thickness 3½ in., thickness of knee 10½ in., and 4 ft. from base of footing to bend at knee. A concentrated load of 13 tons was gradually applied at the crown by means of a balanced platform loaded with brick and bags of cement. When the crown section became overstressed it continued to function but the additional internal work was transferred to the knee sections. Thus the ultimate capacity of the structure as a whole was not limited by the strength of the weakest part. This behavior is characteristic of such statically indeterminate structures. The structure failed at the quarter-point, due to careless steel placement, before its full capacity was reached, although the computed unit stresses at the crown were 78,400 lb. in the steel and 4,700 in the concrete.

The inherent strength of the rigid-frame design, indicated by this test, would seem to warrant the use of higher working stresses.

Adaptability—Rigid-frame bridge design posesses almost unlimited adaptability to architectural treatment. Beam and arch construction impose rather narrow limitations on the architect.

The possibilities of rigid-frame design have hardly begun to be realized, however. The designer of this type can control the external bending moment to be resisted at any particular point of a rigid frame having variable moment of inertia, by varying the properties of other sections so that any general shape may be assumed; the exact proportions may then be determined by the rules of internal work. An example of this control was developed in the design of the Palmer Ave. bridge at Yonkers, for the Westchester County Park Commission. The preliminary design indicated prohibitive stresses at the crown. Instead of increasing the crown thickness to meet stress conditions and thus raising the approaches to meet this increase in thickness, the crown was made thinner; less work was done in this region and more performed at the knees, and the required conditions of stress were satisfactorily met.

Examples of Rigid Frames—Fig. 1 shows one form of architectural treatment of a solid-section simple frame; a stone-faced bridge. A similar concrete-surfaced bridge has been built where the environment required less elaborate finish. Fig. 4 shows the construction details.

For spans over 65 to 70 ft., the saving in quantities in a ribbed design (Figs. 5 and 6) a little more than offsets the saving in formwork for the simpler solid-section frame. The ribbed design, however, requires a greater depth from underclearance to roadway grade

over the structure, and this may have sufficient effect on the quantities in the approaches to require consideration. It is worth noting in this connection that a ribbed frame is preferable to a solid-section frame for a heavily skewed bridge (several such have been built), in view of the fact that great uncertainty exists as to the distribution of stress in a solid skewed structure.

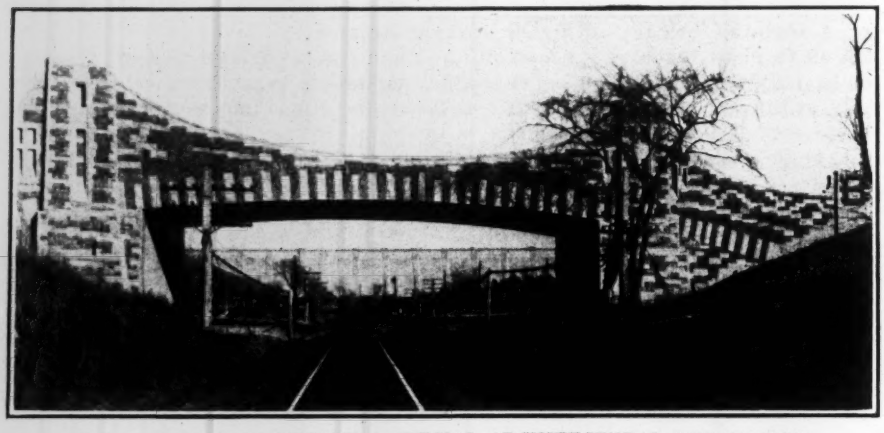


FIG. 7—VALHALLA BRIDGE, A SPECIAL ARCHITECTURAL UTILIZATION OF RIGID-FRAME CONSTRUCTION

Figures 5 and 6 show structural details for 2-span and 3-span ribbed-type rigid frames. These are deck bridges.

The Valhalla Bridge on the Bronx Parkway, described in *Engineering News-Record* of July 2, 1925, p. 16, is the longest rigid-frame bridge of either solid or ribbed type yet built by either commission, the clear span being about 100 ft. This is a through bridge.

Other interesting structural forms have been designed by the engineering department of the Westchester County Park Commission, but the architectural treatment consisted of superimposing old architectural forms on the new structures. As indeterminate frame design develops in this country under economic pressure, once its great structural advantages are fully realized, architects will exercise their ingenuity in order to take advantage of its artistic possibilities as well.

Design Methods—Only brief mention will be made here of the mathematical methods used by the writer in the design of rigid frames, in view of the fact that Prof. Beggs' deformeter method is destined to supersede the tedious mathematical processes now required in such work. Very few engineers appreciate the importance of his work, or the effect it will have on structural design.

The first design for the Swain St. bridge, a solid-section simple frame, was made by the slope-deflection method. General formulas derived for a frame of constant section could not be applied to a structure of variable moment of inertia, so that it was necessary to resort to first principles, and devise original methods of treatment. Later, similar frames were analyzed as two-hinged arches, the hinges being assumed at the footings. Restraint at the footings was allowed for by an expedient described by the writer in *Engineering News-Record* of July 24, 1924. This was a satisfactory method and much simpler than the slope-deflection method.

More complicated rigid frames, as for example that of Fig. 6, cannot be solved by approximate methods, and the modified slope-deflection method was used. This required careful mathematical analysis. Later structures have been designed by a new method, not yet published, developed by Henry G. Babcock of the Westchester County Park Commission designing department, which method abbreviates the mathematical work of design to a great extent and can be applied with less liability to error.

Applying the Beggs Mechanical Method—As the structural program of the Westchester County Park Commission developed, and difficulty was experienced in recruiting a numerically adequate force of competent designers, it became evident that other than mathematical methods of analysis must be adopted. Beggs' method had been demonstrated before the American Society of Civil Engineers in 1924. Its reliability and accuracy had been fully established by the experience of the Swiss Railways and the Illinois Central R.R., and by studies made in the research department of the Massachusetts Institute of Technology and the Universities of Princeton, Ohio State and Toronto. After Prof. Beggs gave a thorough demonstration in his Princeton laboratory a complete set of his deformeter gages and filar micrometer microscopes was purchased for the Westchester County Park Commission's designing department upon recommendation of L. G. Holleran, deputy chief engineer. The subsequent experience of the commission with this method has been highly satisfactory.

A flat model of the structure (Fig. 9) is made of elastic material, the width at any section being proportional to the cube root of the moment of inertia of the corresponding section in the structure. Three-dimensional structures such as ribbed frames having

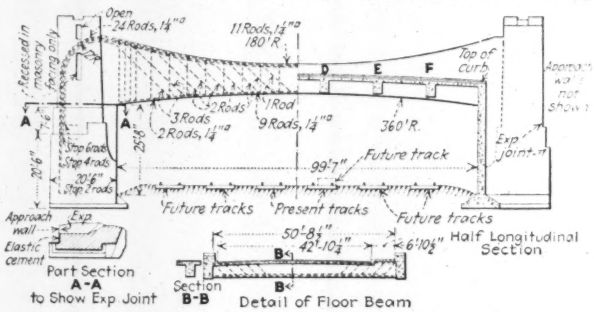


FIG. 8—GIRDER AND SLAB STRUCTURE OF VALHALLA BRIDGE

T-shaped sections may thus be analyzed by means of two-dimensional models.

Models cut from homogeneous materials may be relied upon to give results that are substantially correct as applied to structures built of such composite materials even as reinforced concrete. The approximation involved is no greater than is involved by the application of mathematical methods of analysis, in which elastic properties are calculated for the gross moments of inertia of the uncracked sections, thus assuming practical homogeneity. The reliability of theory based on such assumptions is moreover proven by numerous

tests such as those of Abe (Univ. of Illinois Bulletin 107) and the government tests of Slater (Proc. Am. Conc. Inst. 1919) on constant-section rigid frames. Mathematical methods do, however, neglect the effect of shear deformation and other small factors that are

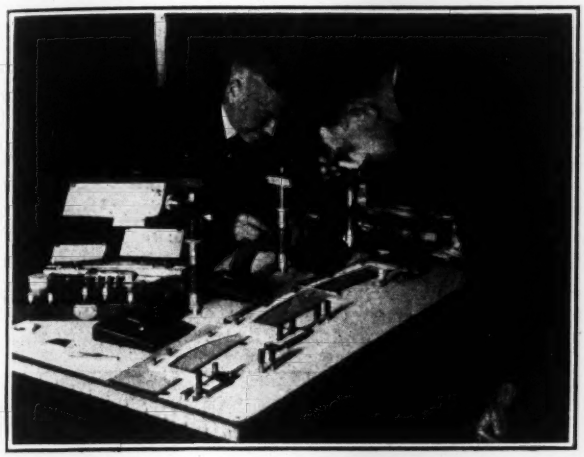


FIG. 9—ANALYZING A TWO-SPAN FRAME BY THE DEFORMETER METHOD

automatically registered in the models, and are therefore probably less reliable than the physical methods of analysis. Stresses of course are figured on the cracked sections.

The model is deflected a known amount at the support, in the direction of the desired component of the reaction, and the corresponding deflection at the point of application of the assumed load and in the direction of the load is measured. For example, in Fig. 10 suppose we wish to find the vertical and horizontal components of the reaction and the restraining moment at B produced by a load P, the structure being here assumed fixed at the supports. No actual load is applied at P, the process being simply the measurement of relative deflections, as follows:

(1) Fix the model at A, C and D. Move point B vertically a known amount d_1, without permitting rotation of the base at B. Measure carefully the corresponding deflection d_2 in the direction of application

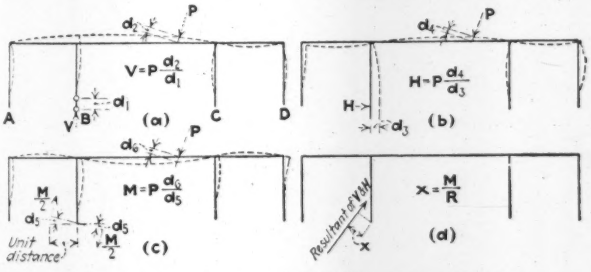


FIG. 10—APPLICATION OF BEGGS METHOD

of P. Then it may be shown that the vertical component of the reaction caused by P will be $V = Pd_2/d_1$.

(2) Restore the model to its unstrained position. Move point B horizontally a known amount d_3 (sketch b), again without permitting rotation of B. Measure the corresponding movement of P, or d_4; then $H = Pd_4/d_3$.

(3) Restore the model as before. Rotate point B (sketch C) and measure the rotation d_6 and the deflection d_5. Then $M = mPd_6/d_5$, in which m is the scale ratio of the model.

(4) Having H, V and M, the amount, direction and point of application of R_B can be found. In the same manner the reactions at A, C and D may be determined and influence lines for each reaction found.

The deformeter gages invented by Prof. Beggs, which are capable of producing deflections accurately to 1/40,000 in., and the filar micrometer microscopes for measuring the deflections, are the mechanical means of applying the above principles. As the elastic medium for the models, first-class cardboard of uniform thickness has been found to be entirely satisfactory under the minute distortions necessary for microscopic measurement. The models are placed horizontally on small steel bearing balls which roll on plate glass so as to minimize friction. Having first calibrated the deformeter gages in terms of the microscope scales, the small known displacements at the reactions to be

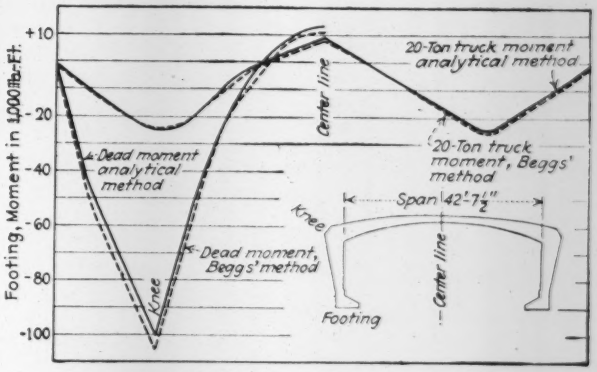


FIG. 11—MECHANICAL ANALYSIS COMPARED WITH CALCULATION

analyzed are successively produced by means of these gages and the corresponding deflections at the loads are then measured by means of the micrometer microscopes.

Fig. 11 shows a comparison of results obtained by Beggs' method and by an analytical method for an actual structure designed for the Bronx Parkway Commission. The agreement is seen to be substantially perfect.

Mosquito Control Cuts Malaria in Memphis

Malaria death rates in Memphis have been cut materially by mosquito control work carried on for the last nine years. For the nine-year period before initiating the control the average annual death rate was 74.6 per 100,000. Control cut this figure to 21 with the low mark of 9.2 for 1925. W. G. Stromquist, sanitary engineer attached to the Memphis Department of Health, is in charge of the control. J. A. LePrince, chairman, Committee on Engineering of the National Malaria Committee, with headquarters in Memphis, states that the campaign in Yazoo County, Miss., now four years old, cost less than 60c. per capita annually and in 1925 there was but 15 per cent of the average malaria sickness of four or five years ago. In cotton belt areas with mosquito control, 75 per cent of the crop was gathered when prices reached their peak while in similarly situated sections not under control less than 50 per cent was gathered. George Parker is sanitary engineer in charge in Mississippi.

Separate Sludge-Digestion System For Small Town Use

Tabular Data for Ten Towns—Hartford, Wis., Plant Has Bar Screens, Clarifier and Digester With Mechanical Agitator

By Jerry Donohue
President, The Jerry Donohue Engineering Co., Sheboygan, Wis.

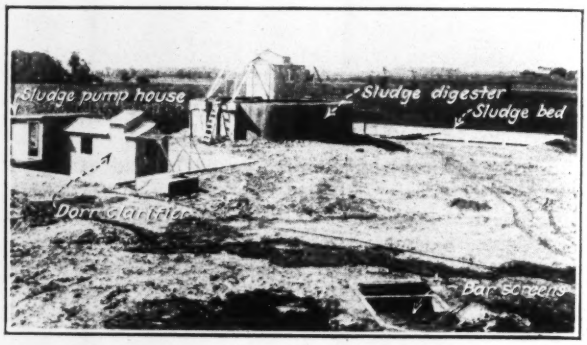
SEPARATE sludge digestion for small cities and villages is offered as a solution of many of the difficulties and problems that communities are experiencing in the disposal of sewage and as a remedy to many operating difficulties of their sewage disposal plants. Some of these difficulties usually encountered are enumerated in order that the designer might appreciate the conditions that prompted the selection of this particular type of plant for Hartford, Wis., which has experienced many of these troubles: (1) Isolation, neglect and lack of attention in operation; (2) overloading the plant by a contribution of industrial waste not originally intended for the city or village sewer; (3) overloading the plant by the addition of territory, or by the sudden growth of population for which no original provision was made; (4) insufficient sludge storage and inefficient methods for removing and drying the sludge; (5) permitting creameries, pea-canning factories and other industries producing strong waste to dispose of their sewage into the municipal sanitary sewer without primary treatment. The accompanying table gives data for ten cities which have adopted clarifiers, or settling tanks with rotating plows on their bottoms from which the sludge passes to digestion tanks provided with revolving stirrers.

One of these ten places is Hartford, Wis., a city of 4,510 people in 1920, located 25 miles northwest of Milwaukee in Washington County. The Rubicon, a small stream with a minimum flow not to exceed 100 min.-ft., carries the city sewage, the storm water and the industrial waste of that city to the Rock River. The sanitary sewer system, separate from the storm water system, has been in operation for twenty years. An old-type single-story septic tank served the city's needs until the load became too great and subsequent stream pollution resulted. Due credit is to be given to the city officials for making the subject of sewage disposal a special study, for they visited many other plants and became familiar with the problem in general. The consulting engineers studied the problem for two years, analyzing the construction difficulties and operating troubles before recommending a separate sludge-digestion system. The plant at Hartford is the first small plant of its type in Wisconsin, and is one of the plants visited by Dr. Karl Imhoff on his recent American trip reviewed by him in *Engineering News-Record*, July 30, 1925, p. 180.

The plant consists of a Dorr clarifier, a sludge-digestion tank and a sludge bed. Provision is made in the plans to install an aeration unit at the head of the clarifier, should further treatment be found necessary. In that event the clarifier would be used to settle the activated sludge which will be disposed of in the digestion unit. This treatment, however, may be several years off but when the aeration unit is needed the plant will be operated on a seasonal basis, activation during the summer and sedimentation only during the cold months of the year.

Bar Screen—Before entering the clarifier, the sewage passes through a bar screen with ¾-in. openings set at an angle of 45 deg. It is necessary to clean the bars about twice a day. Screenings amounting to 1 cu.ft. per day are placed on the sludge bed and disposed of with the dried sludge.

Clarifier—The clarifier is 30x30 ft. in plan, with a water depth at the side of 5 ft. 2 in., and a detention period of 2¾ hours. A 2-hp. motor drives the plows at the rate of one revolution in eight minutes, which is not sufficient to cause currents or eddies. The plows are operated continuously. A 40-g.p.m. diaphragm sludge pump of the pressure type, cut down to a 20-g.p.m. capacity to meet the present sewage output, draws the sludge from the central cone of the clarifier and discharges it into the digester. The sludge pump does not operate at night and has been averaging about two hours' operation per day. The night flow is permitted to pass through the clarifier (allowing the sludge to accumulate in the bottom), but this sludge is immediately pumped in the morning when the operator starts the plant.



HARTFORD DISPOSAL PLANT CONSISTING OF CLARIFIER, CIRCULAR DIGESTER AND SLUDGE BED

Both clarifier- and digester-driving mechanism housed in corrugated asbestos roofing to withstand gases, supported on frames built up on the trusses. Walls are raised above flood water levels.

Sludge Digester—The digester is a 38-ft. circular tank, with an effective water depth of 15 ft. It is equipped with a mechanical agitator consisting of a suspended central shaft to which are attached two sets of arms, one operating on the bottom of the tank and one 2 in. above the surface of the sludge. From the upper arms, which are built in the form of channel bars, chains are suspended into the liquid. The arms revolve once in 16 minutes. The sludge enters the digester at the center and is distributed over the entire surface by the revolving channel arms. The supernatant liquid displaced by the incoming sludge is returned to the clarifier where it is mixed with the incoming raw sewage. (This supernatant liquid should be discharged below the surface of the clarifier for odors are likely to develop at the point where this liquid mixes with the raw sewage.)

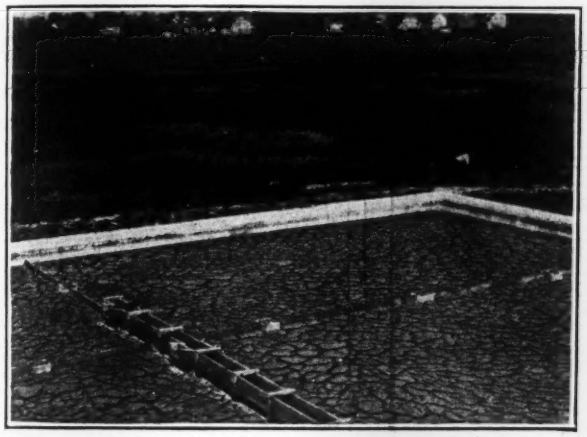
Sludge Bed—From the digester the sludge flows through a wooden channel to a 40x80-ft. sludge bed in four compartments, with tile underdrains laid 2 ft. apart on a concrete floor. The filter medium is 3 in. of fine sand on 18 in. of broken stone in two layers—the upper of ¼- to ¾-in. material, the lower 12 in. of ¾- to 2-in.

SEWAGE CLARIFIERS WITH SEPARATE DIGESTION OF SLUDGE

City	Date installed	Population Served	Size of Clarifier Ft.	Size of Digester Ft.	Volume Treated M.G.D.	Detention in Clarifier Hr.	Cu Ft. Per Capita in Digester
Brownsville, Texas	Aug. 1923	15,000	45	35 diam. x 16 deep	1	2	1
Charlotte, N. C.	Jan. 1925	50,000	100	4—37 sq.*	5	2½	1.15
Bartow, Fla.	Sept., 1924	4,000	30	26 diam. x 15 deep	0.4	2	2
Hartford, Wis.	Aug., 1924	5,500	30	38 diam.	0.4	2½	3
Sheboygan, Wis.	Nov., 1924	5,000	30	36 diam.	0.5	2	3
Kiel, Wis.	1925	1,600	20	25 diam.	0.16	2	3
Wheaton, Ill.	1925	7,500	Two 30	2—30 diam.*	0.75	4	2.5
Leetonia, Ohio	1925	2,688	25	2—12.5 x 26*	0.3	3	2.8
Ridgewood, N. J.	1925	20,000 (est. max.)	46	30 x 30* × 15 deep	0.6 to 2	2 at max.	2.0
Vero, Fla.	1925–1926	12,000	30	30 diam. x 16 deep	1.2	2 at max.	3.3

* Plain hopper bottom tanks. All others have mechanisms.

Operating Results—The plant was put in operation in August, 1924. Bacterial action was started in the digester by seeding with several wagon loads of stale horse manure. A short time afterwards, gas bubbles evolved from the surface and this action continued through the winter. The digester has a wooden cover, supplemented during the winter with marsh hay. In December, with air temperature of 25 deg. F., the inflow sewage had a temperature of 52 deg. F. The sewage and the liquid in the digester were 46 deg. F. The fact that the entire surface of the digester acts as a gas vent affords sufficient space for the floating sludge to



SLUDGE DRIES AND CRACKS WITHIN 5 TO 7 DAYS
Note the proximity of the plant to houses.

discharge its gases and sink. The agitating mechanism keeps this floating sludge broken up and allows the gas to escape.

In April after the plant had been in operation for six months there was an accumulation of 14½ in. of scum on the digester. Immediately below, the scum was semi-liquid, making no definite plane between the settled sludge and the liquid. Two months later, in June, 1925, the scum was reduced to 3 in. and there was approximately 4½ ft. of sludge in the digester. At this time small quantities of sludge were drawn off to a depth of about 6 in. on the sludge bed. The sludge was black, with a slight, tarry odor. No difficulty was experienced in drawing this sludge. The weather was cool and dry and in 36 hours the sludge had cracked, indicating good drying conditions. Within a week the sludge was removed from the sludge bed. During one year's operation the sludge beds had to be used only twice. The sludge dried out each time in 5 to 7 days.

Two determinations of the removal of settleable solids by the clarifier were made in 1925, each by a different method. In April a representative of the Dorr Co., using Imhoff tubes with one hour settlement, found a 94 to 99 per cent removal, while in August, Prof. C. I. Corp of the Sanitary Engineering Department of the Wisconsin State Board of Health, testing by weight, found a 73 per cent removal. The clarifier is practically free from scum and what little scum there is consists of kitchen grease. The clarifier has not been skimmed since it was put into operation. The effluent is somewhat milky in color and consistency and has practically no odor.

At the time that the engineering analysis was made of the advantages of this type of plant over deeper gravity plants it was estimated that the cost of operation based upon current cost at 6c. per kw.-hr. would amount to approximately $1.76 per day. Accurate records of current consumption for the year ending September, 1925, show that a total of 5,179 kw.-hr. were used at a total cost of $279 or an average of 77c. per day for the total power consumption in operating the clarifying unit, the digester mechanism and the sludge pump.

In the design, construction and operation of the plant, the engineers had the co-operation of J. H. G. Lieven, mayor, H. J. Peters, superintendent of utilities, and the contractors, Eckerman & Ruddell Construction Co., of Milwaukee. The plant was constructed under the direct supervision of B. J. Hartman of the Jerry Donohue Engineering Company.

Garbage Service a Governmental Function

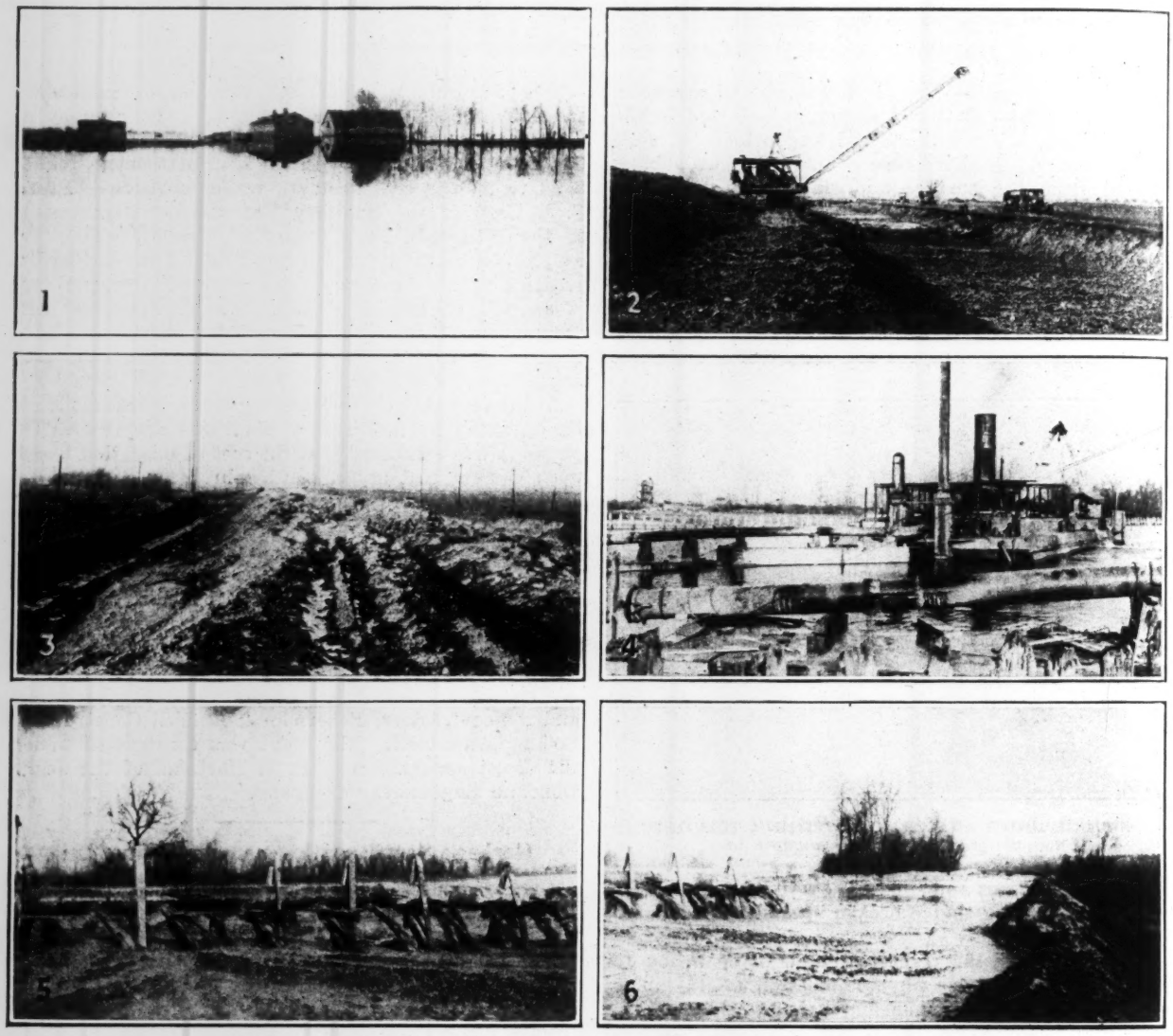
Garbage collection has been held to be a governmental function by the Supreme Court of Arizona and on that account damages from the city of Phoenix to an employee engaged in collecting garbage have been denied by the court, thus sustaining the decision of the trial court. The employee who sought damages was seriously injured by jumping from a garbage truck which was about to plunge into a deep canal, a fellow employee having lost control of the truck through excessive speed and defective brakes and steering gear. The decision was on demurrer, to the effect that the city was operating the truck in the exercise of a governmental function. The Supreme Court, in a decision rendered Oct. 17, 1925 (*Jones vs. City of Phoenix*, 239 Pac. 1030; abstracted in U. S. *Public Health Reports*, Jan. 29, 1926) stated that almost without exception the courts have held that the sanitary service of a city is governmental and that when so municipalities are, not liable for damages.

Construction of Hydraulic Fill Road Embankment

Fill 56 Ft. Wide Averaging Over 100,000 Cu.Yd. a Mile Built by Dragline Excavators and Hydraulic Dredge for Michigan Road

ABOUT 890,000 cu.yd. of earth is being moved by dragline excavators and hydraulic dredge in building a new broad highway between Saginaw and Bay City, Mich., 8.39 miles. The entire operation is embankment across the overflow lands south of Bay City and along the bottom land bordering the east bank of the Saginaw River. This embankment is 56 ft. wide to carry a 40-ft. pavement and has side slopes of 1 on 4. From Bay City to the river, there are about 119,000 cu.yd. of dragline work and along the river are 700,967 cu.yd. of hydraulic fill. With the hydraulic fill work there are some 71,295 cu.yd. of cut and waste. Altogether these volumes make one of the notable earth moving operations of recent years in road construction—a continuous fill running more than 100,000 cu.yd. a mile for over eight miles.

The location of the road is substantially all in the flood plain of the Saginaw River. Views of the flats south of Bay City when the floods are high and of levee and fill are given below. Along the river bank the conditions were somewhat the same though there were high places and also there was an irregular fill formed by the spoil from a previous deepening of the river by the U. S. Army Engineers. A continuous fill was called for to keep the road above flood level. There were two conditions, first the flood plains south from Bay City where the line was away from the river and second the river-bank road never far from the stream. An embankment made from borrow was the natural construction on the line away from the river and it was planned with the cross-section shown by Fig. 7. Along the river a fill from channel excavation suggested itself and was adopted; this hydraulic fill section is shown



FIGS. 1-6—CONSTRUCTION OPERATIONS ON SAGINAW-BAY CITY ROAD

Fig. 1—Portion of road location in flood time. Fig. 2—Dragline throwing up embankment from borrow canal. Fig. 3—Top of dragline fill. Fig. 4—Dredge for hydraulic fill. Fig. 5—Discharge end of pipe line. Fig. 6—Fill made between levees.

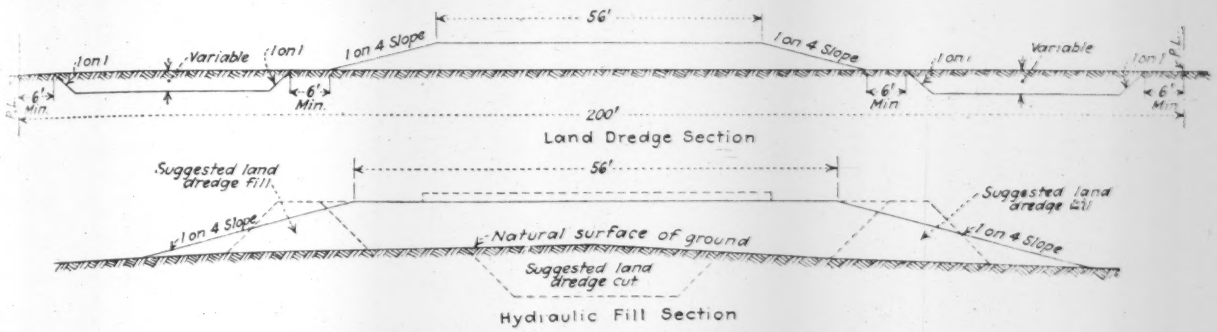


FIG. 7—SECTIONS OF SAGINAW-BAY CITY ROAD EMBANKMENT

by Fig. 7. Construction therefore involves a dragline excavator operation across the flats and a hydraulic dredge operation along the river shore.

On the dragline work the task was to throw up an embankment between two continuous borrow trenches. The plan was to put a crawler-mounted dragline on each berm (see Fig. 7) and throw up the fill by cross-cutting the trench. Fig. 2 shows the operation clearly. Another view shows the rough top of the fill as thrown up by the excavators. These machines have 35 ft. booms and 1¼ cu.yd. buckets and under good average conditions have put about 700 cu.yd. daily into the fill. The material is largely clay. The bid price for 118,738 cu.yd. was 35c. a yard. This includes trimming the ditch and slopes and smoothing the top to rough grade. Virtually the embankment building is one machine operation from borrow to fill; the plant is confined to two machine units not including a top surfacing grader.

On the hydraulic fill portion besides the main dredging operation there is levee building by small draglines to confine the water-deposited material as indicated by Fig. 7. The dredging operation presents no variation from familiar practice. A new 20-in. dredge, having a modern equipment of pumps, engines, transmission, cutter machinery, spuds and auxiliaries, has been built for the work. Figs. 4 and 5 show the dredge and discharge lines. At no place will the discharge line be over 1,000 ft. long and generally the length will be shorter. The ordinary lift above the pump will run from 3 to 10 ft. and will probably never exceed 15 ft. The suction head will be from 6 to 18 ft. In operation the dredge moves down the river making a regular channel cut and putting the material into the road fill as indicated by the views. The estimates call for placing something over 700,000 cu.yd. by dredge at the bid price of 47c. a cubic yard.

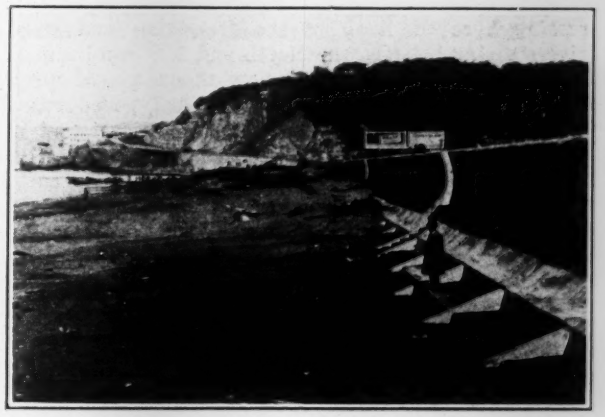
The dimensions of dredge fill and dragline excavator embankment are given in Fig. 7. They provide for a 40-ft. paved roadway, but only half the pavement width will be constructed at the beginning. This construction will correspond to the standard concrete pavement practice of the Michigan Highway Department. As indicated on the map published in *Engineering News-Record*, March 4, 1926, p. 350, the Saginaw-Bay City road is a part of the development of Michigan trunk line 10, of which the Detroit-Pontiac superhighway is another part. Running along the river the road has scenic values which have been conserved by securing with the right-of-way all the land to the river edge for the greater portion of the route.

The new road is being built under the state highway department. F. F. Rogers, commissioner, G. C. Dillman, deputy commissioner, and A. L. Burridge, supervising engineer. The contractor for the hydraulic fill is W. J. Meagher, Bay City, Mich., and for the dry fill is J. H. Woodrow, Port Huron, Mich.

Groined Concrete Sea-Wall Protects Beach

A STORM of unusual severity that swept the Pacific Coast Feb. 12 served to emphasize the substantial design of a concrete sea-wall built on the ocean front at San Francisco. This wall has, since 1915, successfully maintained an attractive sandy beach well to the seaward of the shore line that varied, prior to 1915, over a considerable range determined by storm conditions. The success of the structure is of greater interest because it was built without a rock foundation.

The Feb. 12 storm damage in the vicinity of this sea-wall was augmented by the heavy wreckage of a



ESPLANADE SEA-WALL AT SAN FRANCISCO BEACH
In center background wreckage of barge and broken steel pier.

barge that came ashore with the storm. The barge wreckage, moved by the waves, entirely destroyed the shore end of the Olympic Salt Water Co.'s steel pier, and heavy fragments, swept still further in by the waves, battered the sea-wall. In a storm just prior to the construction of the sea-wall, the land was washed away 70 ft. behind the line of the present structure.

In the eleven years since the construction of this wall there has been no undermining and no disturbance of the fill behind it which now carries a wide boulevard. In fact, sand tends to accumulate on the ocean side.

This success of the structure is attributed to its design, particularly to the steep and well braced cutoff, the curved crest and the groin-like walls on the inclined base which afford protection against scour.

The wall was designed and built under direction of M. M. O'Shaughnessy, city engineer, San Francisco.

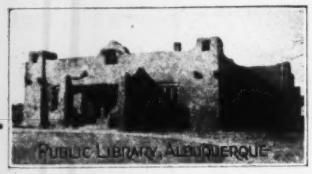
Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

Albuquerque, N.M.



CROSSROADS OF THE SOUTHWEST for 300 years, though incorporated as white man's city less than 50 years. Halfway (about 850 miles) from Kansas City to Los Angeles; and logical point therefore for the Santa Fé to locate large shops employing a maximum of 3,500 men. A sawmill employs 500 men. Headquarters for irrigation carried on in Rio Grande Valley largely and sporadically by Mexicans and Indians for three centuries. Albuquerque is the home of seven large sanitariums, and of thousands of invalids seeking a dry high altitude (5,000 ft. and 6-in. rainfall). Location of the War Mothers Memorial Hospital, of 4,800 beds; a $12,000,000 plant with $25,000,000 endowment now assured will make this city the center of national tuberculosis research. City is furnishing a 640-acre site with water, sewers and paving free. Incorporated in 1885, settled 300 years ago. Population, 1920 census, 15,000 in the 1,645 acres. Recently this acreage was increased to 8,176 acres by annexation bringing in 5,000 people. Estimated present population, 26,000.

FOR 300 years Albuquerque has thrived as a crossing of trails. Coronado came north seeking the golden fleece of hidden treasure and was crossed here by Indians riding west. The Forty-Niners trekked west, crossing here the trail of the freighters and stage drivers plying between the North and Mexican borders. Then came the railroad and now thousands of automobiles are led into the city over hard paved roads extending 18 miles to the north, 10 to the east and 12 to the south. The old trails are returning in popularity. Everybody stops here. Fred Harvey, with his curio buying headquarters here for years, has made the railroad establishment so attractive that few travelers knew aught else of the city. The engineers' highways now bring thither the flivver-crop as well as the balloon-tired four-wheel brake tourist looking for $5-a-day accommodations, meaning, first, water for a bath—and Albuquerque engineers provide it with no restrictions.

Transportation brought people here but water—and climate—have kept them. Both are inextricably bound up in everything that interests most the engineer studying Albuquerque. Transportation after one arrives is expedited by a maximum of paving on 60-ft. streets laid out regularly, parallel and at right angles to the railroad; and water is available from the underground supply coursing through the sands of the flat flood plain of the Rio Grande which touches one corner only of the rectangular-shaped city but which has in early days left the thread of the stream after a spring flood close to the west side of the railroad where now stands the business section. An adobe levee of mud bricks, 9x12x4 in., from a point 15 miles above the city, has, since no one knows how far back, deflected the river 2½ to 3 miles to the west. The old levee is broken in many places but has well served to confine the thread of the stream away from the city. No small part of the work of the newly formed Conservancy District taking in 404,000 acres will be to fix still further the river course outside the city limits. Albuquerque has been destined for centuries to be a large city and now with the highways making new avenues of access for new residents and the proposed irrigation developments stabilizing a back country to support them, the engineer is preparing his part for the city to be.

Topography—Located in the north central portion of the state and surrounded on three sides by mountains about 15 miles away, Albuquerque is in the smallest county, Bernalillo, in the state, its boundaries east and west being confined generally by the mountains. The city is near the head of an ever-widening flat flood plain descending 2 ft. to the mile which breaks from the closed canyons about 50 miles upstream where dams have long been projected to store water to stabilize age-old irrigation enterprises.

Drainage—West, or on the river side of the railroad which skirts the flood plain, the city is flat, while east it rises rapidly on 3½ per cent grades. Two distinct types of sewer and drainage systems are necessary. On the flat area where a fall of only 2 ft. per mile is available three pumpings of sewage in 3 miles are necessary before the domestic sewage is finally lifted to the Doten single-story sewage-treatment plant. Ground water, before the sewers are laid, in some of the lowlands is at the surface since the river bed is 2 ft. higher than the surface. Since the whole area is sand, sewer trenching is difficult and in consequence is carried out by hand in close-sheeted trenches. Several broken contractors are charged against it. Sewers at the upstream side of the town usually start 8 ft. deep and progress to about 15 ft. deep when trench pumping reaches the limit and automatic pump stations are installed to lift the sewage up to within 8 ft. of the surface again. It is slow work. The trunk sewers are 18 to 42 in., of monolithic concrete, most of them being 24 in. in diameter. The clay pipe collecting lines are laid with asphalt or cement and oakum joints to insure tightness. The east or foothill side is on gravel with enough adobe usually so that trenches stand up but machines are not used for contracts have been small and it is hard to compete with $2 to $2.40 labor.

Storm drains—it does not take much of a system to care for 6-in. annual rainfall and ½ in. in 1 hour would be cause for newspaper extras—lead from the foothills to an irrigation ditch at the foot of the slope parallel to the railroad. On the river side drains lead to a 3½x4-ft. concrete box culvert which is laid on the surface of the ground at its lower end. Street gutters slope from intersections both ways to the center of the 300-ft. blocks, about 6 in. Their main use is to carry off flushing water. The gutters are especially flat and are built more with the idea of being easily cleaned by mechanical sweepers than for water carriage.

Paving—Since the underlying material is either sand or gravel and no moisture at the surface is present to freeze, were there freezing weather, foundation conditions are nearly ideal. But one type of pavement has been laid and that covers 30 miles, practically all of the streets in the city previous to the recent annexation. Bitulithic, 2 in. thick on a 5-in. concrete base

or a 3-in. black base, has been laid at a cost of from $2.20 to $3.90 per sq.yd. including grading and excavation but not the monolithic curb and gutter which costs $1.15 per lineal foot. The present costs are about $2.75 per sq.yd. No special provisions are used in the design or construction; a templet set on stakes every 10 ft. transversely and a 10-ft. straight-edge with ¼-in. tolerance longitudinally insures a level road surface. The town is excellently paved with good riding qualities everywhere testifying to the engineer's care in inspection. The first paving was laid in 1912 and had no maintenance until 1923 when a flush coat was put on. The contractor maintains his work under a 5-year bond.

Streets are 60 ft. wide, usually with 32-ft. paved widths in residence districts and 40-ft. widths downtown. Central, an east and west street, is 80 ft. wide and has 60 ft. paved. Broadway, 100 ft. wide, north and south, was supposed to be a business street but is mostly residence and business. Crosswalk elevations are absent. Water in the gutters is unheard of. Corner radii are 12 ft. usually, with the maximum of 17 ft. occurring in the residence district.

Curbs have a face of 6 to 10 in. with 1½-in. batter, 1½-in. radius at the base and a slight radius on top. This serves to protect automobile tires. Gutter slabs are 7 in. thick and laid integral with curbs which are 6 in. thick. They are cut for expansion joints by ¼-in. steel templet every 12 ft.

Water Supply—A hard water is obtained from the fine sand strata varying from 60 to 200 ft. deep. Water rises to within 5 ft. of the surface but is drawn down a maximum of 20 ft. Soft water is obtainable at 900 ft. and the railroad has sunk some wells to that depth but the city has not yet incurred the extra expense involved. On the original water-works lot are 27 wells 6 to 12 in. in diameter pumped by motor-driven centrifugals to a settling basin to eliminate sand. Number 8 caps are occasionally exploded in the older wells to free them from fine sand. On a second lot 1,000 ft. away, are six 8-in. wells. New wells will be developed still further up the valley. A 43-year-old 3-m.g.d. reciprocating Holly pump "nearly as good as when new" lifts the water direct to the mains with a 10-m.g. reinforced-concrete reservoir floating on the system in the foothills, 250 ft. above the flat portion of the city. A second high-service reservoir of 3 m.g.d. is fed by an electrically-driven unit at the first reservoir with connections so that 150-lb. instead of the usual 80-lb. pressure can be obtained downtown in case of fire. The average in the residence district is 50-lb., the 50- and 80-lb. areas being valved off from each other.

Mains under the 15 railroad tracks separating the city are of steel. Lines laid in 1885 have been taken out recently, found in good condition, cleaned and repainted on the outside and relaid. A small amount of cast-iron was laid during the War when the steel could not be obtained. Sewers are of dipped galvanized iron with lead connections to the mains.

Albuquerque is 100 per cent metered, uses 100 gal. per capita on the average and 175 gal. maximum. The minimum rate is $1.70 per month for 6,000 gal. with a rate of 15c. per 1,000 above 6,000 gal. in summer and 30c. in winter. There have never been any restrictions, the maximum day calling for 2½ m.g.d. with the old Holly still ½ m.g.d. to go. Since about 400 new houses per year is the growth the engineers see replacement not far off. Leaks are hard to find and a survey has been talked of but so far dependence is placed on irregular night inspections with a Darley detector.

Miscellaneous—All engineering design and construction come to the office of the city engineer, the latest being a library building of which the headpiece herewith is a photograph. An auditorium is now under consideration. Garbage is entirely a private scavenger affair. The water superintendent cares also for sprinkling unpaved streets twice daily and flushing paved streets as needed, usually twice a month. The health department tests the water daily and rarely finds B. coli presumptive positive in 10 c.c. A new park along the river bank is a hobby of the engineer and manager and they have built a winding road from borrow pits at the side to elevate the road 4 ft. above the general level and incidentally protect a residence area back of the park. A well-maintained city dump along the river bank is also made in the form of a levee.

Traffic markings are laid out by the engineers but painted by the police department. An innovation is in marking stalls 13 ft. long on curbs to aid drivers. At all intersections street names are painted on the curb in black letters on a white background. The sloping curb facilitates reading. This is general in western cities but has little vogue east because of difficulty of seeing in winter. The cost is approximately 10 to 15c. per sign, which is usually duplicated four times for each street at each crossing. The signs last from 1 to 3 years.

Sewer work is done by bond issue and paving paid for by special assessments, the property holders having a "protest" day. Either property holders or commissioners may initiate improvements but the latter may put the work through as being of public necessity even though all protest. Work is not often carried out if more than 50 per cent protest. A bond issue of $560,000 for parks, street openings, storm drains, sanitary sewers, water mains and an auditorium and fire station is up for passage at the spring election. A two-thirds vote is necessary. Since a bond issue has never been turned down in Albuquerque the engineers are optimistic over this one.

Organization—With all the above activities and every other activity in the city administration requiring engineering the city engineer, Frank Kimball, has contact. Moreover, the city manager reporting to five commissioners, B. H. Calkins, is also a civil engineer and has general supervision of every activity in the city so that the city may be said to be run by engineers from finances to river control. A staff of an engineer and two assistants in winter is enlarged in the summer to 3 engineers and 2 assistants and a budget of $12,000 is allowed, extended when special improvements are undertaken.

Mr. Kimball has been city engineer six years and Mr. Calkins has been city manager for four years though he had to do with the paving in 1912. If there is any engineering question these two men do not have ready answers for from copper-expansion joints in the reservoir walls to the 110 miles of total street mileage or the 11-day stability test in the sewage-plant effluent, then some one more clever than an itinerant editor must ask the questions. Albuquerque is about to re-elect four commissioners. It's a safe gamble there will be no change in management if the new commissioners want service for the city certainly is getting it now.

Giants Spread Car-Dumped Fill for Alouette Dam

Tough Lumpy Clay Produces Good Dam Embankment When Broken Up and Spread by Semi-Hydraulic Process

By C. E. Blee
Principal Assistant Engineer, Construction Department, British Columbia Electric Railway Co., Ltd.

BEFORE the semi-hydraulic method was decided upon for building the Alouette dam, consideration was given to straight hydraulic-fill, excavating with steam shovels and placing by dredging pumps and pipe lines. There was danger that this method would have produced an excess of fines, it was believed, and that the action of the all-clay embankment during construction could not be definitely predicted. On this account, the closer control of the amount of water used, which is afforded by the semi-hydraulic method, was considered important. Actual experience during construction did not show an excess of fines and, as a matter of fact, the clay embankment gave no trouble due to sloughing or lack of drainage, so these objections to the hydraulic method would not have materialized. However, construction experience did show that it would have been very difficult and costly to have broken down the clay material to permit dredging pumps to handle it.

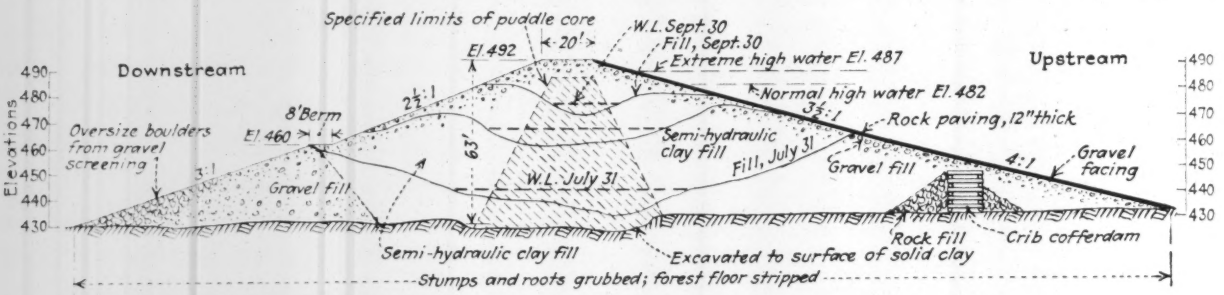


FIG. 1—SECTION OF ALOUETTE DAM SHOWING DIMENSIONS AND MATERIALS

Dam Structure—Alouette dam has recently been completed to provide a storage reservoir for a new hydroelectric development of the British Columbia Electric Railway Co., Ltd., on Alouette Lake, 25 miles due east of Vancouver, B. C. It is an earth fill, 1,000 ft. long on the crest and with a maximum height of 63 ft. above the streambed. Under the dam is a very hard, dense clay overlying a softer clay which at deeper levels gradually changes to a fine, sandy silt. Blasting was necessary for steam shovel excavation of the hard clay. The contents of the dam, measured in settling fill, are:

Item	Cu.Yd.
Clay from spillway excavation	93,000
Clay from borrow pit	15,000
Gravel facing	29,770
Cofferdam embodied in main dam	1,850
Rock paving	3,380
Total	143,000

Hydraulicking Process—All material for embankment was excavated by steam shovels. The general method of placing the fill was to bring in the material in cars, dump it near the outer slopes of the dam, and wash it down toward the center with streams from hydraulic giants. In the meantime a giant mounted on a float in the core pool played its stream on the inner face of the clay fill, washing the fine material down into the pool and leaving the coarse lumps on the outer slopes. The clay lumps were remarkably tenacious and did not break up under the nozzles.

In starting a new lift of the embankment, the gravel for the facing was utilized to build up a roadbed for the dump tracks by depositing it first on either side with side-dump cars, then between the rails with center-dump cars, and progressively jacking up the track through this ballast until a fill 2½ to 3 ft. in height had been built up near the outer slope of the embankment. Then the clay was side-dumped from the inside of this roadbed, and the resulting pile of clay attacked by the stream from the hydraulic giants, or monitors, spreading it in toward the core pool by the force of the jet.

A pumping plant, with a capacity of 1,000-g.p.m. under 125-lb. pressure, was installed on the lake shore at the upstream toe of the dam, and an 8-in. wood-stave pipe was carried completely around the dam with tees at intervals, to supply the spur lines running in to the monitors. The most satisfactory spacing was approximately 50 ft. between monitors. Three monitors were generally used on each side of the dam, these being shifted as the fill progressed. Two nozzles were ordinarily kept in simultaneous operation to avoid excessive pressure. The nozzle tips generally were 1½ in.

The use of monitors for spreading the dump piles proved to be very effective and economical and had the advantage of thoroughly working over with water all of the clay going into the dam. Under the methods ordinarily used in semi-hydraulic fill construction, namely: dumping either from a trestle or from a high built-up embankment, and with a stream playing on the inside of the dump only, a considerable portion of the fill is placed and remains as dry fill. By the methods used on the Alouette dam this objection to semi-hydraulic construction was obviated.

A difficulty encountered at the higher levels was that the monitor jet struck the dump pile with such force as to tend to throw coarse material into the core. This difficulty was overcome by building vertical screens on floats, and anchoring a line of them close in against the edge of the core pool and in front of the monitors in use. This caused the coarse material thrown by the jets to drop at the edge of the pond. The screens were about 10 ft. in height and consisted of 6x6-in. reinforcing mesh, overlain with chicken wire fencing of 1-in. mesh, all fastened to a framework supported on a float made of two cedar logs. These units were built in sections about 40 ft. long, generally with a screen on each side of the float, so that it could be used on either side of the pond by moving it laterally across the pool.

Some difficulty was experienced, especially at the higher levels, in holding the core pool to the specified

limits of core section. The latter were based on making the width of the core, at any level, equal to the distance below the crest of the dam at that point, plus 10 ft. A relatively deep pool was carried, generally 7 to 8 ft., making the width equal to or greater than the specified core width. Thus all the material in the core area was deposited under water, and the voids in the coarse material forming the slopes at the edge of the core were well filled with fines. No great concern therefore was felt over not having the entire specified core area occupied by fine material, precipitated from the pool.

The pool was abandoned when the core had reached approximately El. 482 which is 52 ft. above streambed and is the normal high water level in the reservoir. The side embankments were at this time nearing their ultimate height and the center was filled in by dumping from these, at the same time wetting down with water from the nozzles. The final topping of the dam was made with gravel from a track carried down the center line of the crest.

TWO TYPICAL ANALYSES OF SAMPLES FROM CORE MATERIAL

	Sampled Aug. 9 El. 444 Ball Penetration, 10 Ft. Per Cent	Sampled Sep. 7 El. 461 Ball Penetration, 0.8 Ft. Per Cent
On 100 mesh	6.84	3.62
200 mesh	4.72	3.05
Diameter of Particles, Millimeters		
0.075 to 0.050	18.50	28.67
0.050 to 0.025	13.75	14.16
0.025 to 0.010	23.65	20.71
0.010 to 0.005	22.04	25.92
Less than 0.005	12.59	3.87

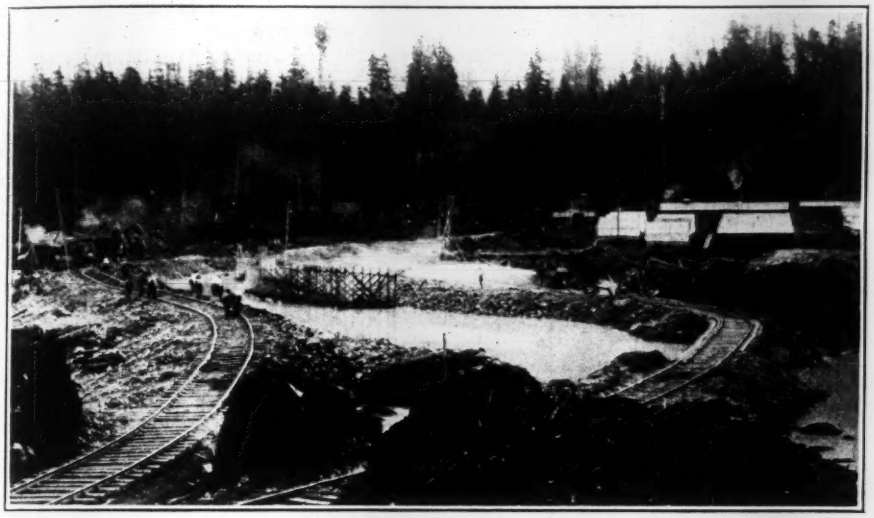


FIG. 2—ALOUETTE DAM UNDER CONSTRUCTION
Note core pool, dump tracks on each side, monitors washing down dumped fill and floating screens to keep streams from driving coarse lumps into pool.

Overflow from the pool carried off an appreciable amount of fine material but less than would be the case in straight hydraulic fill. Since the quantity of water to be handled was comparatively small, it was removed by a pump mounted on a float in the pond. When the dam reached El. 470 the pump was abandoned and an 8-in. slip-joint steel pipe was embedded in the downstream bank at one end of the dam. This pipe led from a standpipe in the core area to the toe of the fill. The standpipe consisted of a square timber box filled up as the work advanced.

Progress and Results—A 3,500-ft. tunnel from Alou ette Lake into Stave Lake, forming a permanent part of the Alouette power development, was utilized to divert the waters of the Alouette River during the construction of the dam. The starting of the embankment depended upon the completion of this tunnel. Water was diverted through the tunnel June 17, 1925, the cofferdam was closed June 21, and the work of stripping the section of core area lying in the river channel was started at once with a small dragline excavator. Meanwhile the construction of the embankment progressed in a limited way at the outer toes of the dam, but it was July 13 before the stripping was completed and the placing of the fill started in ea. nest.

On Oct. 30 the embankment was at El. 485, or 55 ft. above the river bed. From that time on the progress was slower due to finishing and trimming the embankment and cleaning up the excavation in the spillway. The maximum progress in a month was in September when 35,070 cu.yd. of embankment were placed in 25 days of two 8-hr. shifts. On the best two-shift day, 1,954 cu.yd. were placed.

Observations during construction showed practically no settlement of the completed fill at El. 460 and a settlement of 0.2 ft. at El. 480. The dam is being finished 12 in. above grade over the old stream channel, where the fill reaches its maximum height of 63 ft. This super-elevation is tapered out toward the ends of the dam. The clay deposited in the outer portions of the embankment remained in the form of lumps which gave good drainage and increased stability. Penetration tests were taken weekly on the core with a 6-in. cast-iron ball. These showed that the material solidified with comparative rapidity. In the lower portions a maximum penetration of 10 ft. below the surface of the core was shown, grading to no penetration in the upper portions.

Finishing and Paving—The upstream face of the dam was covered with hand-placed rock paving using rock from talus slopes along the lake. This was loaded on scows and transported to a construction dock where it was transferred to cars and hauled on to the face of the dam, over tracks left in place at various levels for this purpose. The specifications called for a rock paving varying from 11 to 16 in. in thickness with an average of 12 in., but the rock as placed averaged somewhat larger. At the outset, a very carefully surfaced paving was placed, each rock being fitted and bedded and the whole chinked to give a compact facing. The cost of this work was more than was justified and decreasing the bedding and fitting cut the cost one-half.

The design and supervision of all work in connection with the Alouette development is under the direction of E. E. Carpenter, consulting engineer of the British Columbia Electric Railway Co., Ltd. The contractor handling the construction of the Alouette dam is Pacific Engineers, Ltd., C. A. Strong, general manager, and C. A. Kallman, superintendent.

Specifying Concrete by Water-Cement Ratio Alone

Job Procedure in Applying Strength Specification to Construction of Reinforced-Concrete Office Building in Chicago

CONTROL of concrete quality was effected during the recent construction of the new office building of the Portland Cement Association in Chicago by means of a specification based solely on the water-cement ratio. Neither special equipment nor a special testing organization was used. Experience on this job demonstrated that no necessity existed for an experienced testing organization to control the proportions. The determination of the proportions for each class of concrete was simple, as it was done by trial with the first few batches,

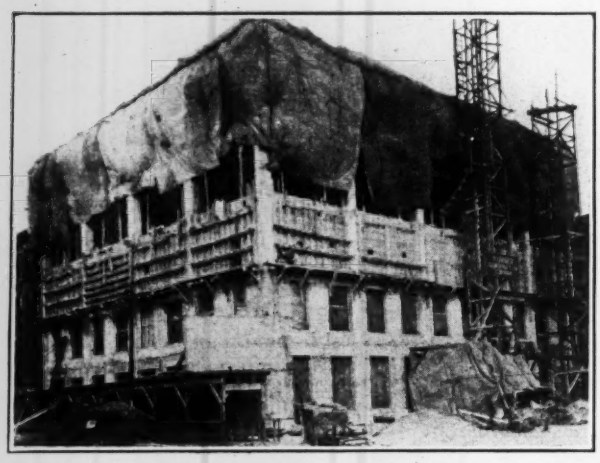


FIG. 1—PORTLAND CEMENT ASSOCIATION BUILDING UNDER CONSTRUCTION

none of the computations usually considered a necessary part of scientific control of concrete being resorted to. Subsequent minor changes in proportions were made entirely by the concrete foremen. The water-measuring device was set, with proper allowance for moisture, by the architect's representative. The only duties performed by the testing organization as a part of the control of the concrete consisted in making the moisture determination on the aggregates, which could have been done by any intelligent man.

The building, 80x100 ft. in plan, consisted of a basement, part sub-basement, 5 floors and roof. The foundations were carried on thirty 4 and 5-ft. diameter caissons resting on hardpan at a depth of about 75 ft.

In the specification, under "Suggestions to Bidders," the attention of the contractor was especially called to the strength specification which fixed only a limited volume of water per sack of cement rather than giving required proportions of aggregate as is customarily done. Maximum slumps for the different portions of the work were stated, to avoid any possible argument over unnecessarily wet mixtures or accumulation of laitance. Also, under this head, practical suggestions were given as to operating procedure. The contractor was permitted to use such aggregates and such proportions as in his judgment would prove economical and give a workable mix. Parts of the specification follow:

"It is suggested that trial mixtures be made to determine the cement requirements for the different consistencies, which the contractor will use in the various portions of the building. In such trial batches, the moisture contained in the aggregate must be taken into account in securing the water cement ratio specified.

"Attention is further called to the manner in which allowance must be made for batch to batch fluctuations in water content. Instead of specifying the average water-cement ratio desired with a definite tolerance the maximum permissible values have been given requiring the contractor to conduct operations in such manner that those shall at no time be exceeded. This will enable the contractor to obtain increased economy, as his methods of controlling the water are perfected, for the smaller the variation, the closer the maximum permissible limit can be approximated by the average water content.

"The principal difficulties in controlling the mixtures under this type of specification will arise from variations in moisture content and grading of the aggregate and some inaccuracies in measurement—principally with the sand. If methods of measuring aggregate are adopted which will give uniform quantities from batch to batch, the annoyance of moisture variation in sand will be considerably minimized. For with uniformity in quantities of materials and in grading (the latter obtained by getting aggregates from the same source for any one day's operations) the correct moisture content in the concrete can be gaged with considerable

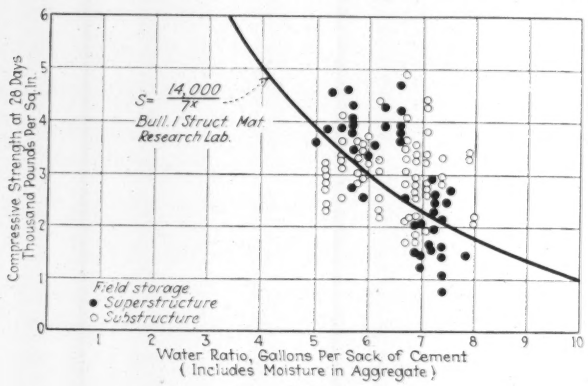


FIG. 2—TEST RESULTS AND STRENGTH-LAW CURVE UPON WHICH SPECIFICATION IS BASED

Note that the two groups of water-ratios shown averaging about 5½ and 7 gal. respectively, are about ½ gal. under the specified limits for the 2,000 and 2,900-lb. concrete.

accuracy by the workability or consistency as indicated by the slump test or by its appearance.

"Determination of the moisture content in the aggregate from time to time will be necessary in order that the water content will at all times be within the water-cement ratio specified. The measurement of moisture in the aggregate within the limit of accuracy specified, 2 lb. of water in 100 lb. of aggregate, should offer no great difficulty. Either drying and weighing a small sample or inundation will give results satisfactory for the purpose."

The specification was written by F. R. McMillan, associate engineer, Structural Materials Research Laboratory, Lewis Institute, Chicago, and Stanton Walker, now director, Engineering and Research Division, National Sand and Gravel Association, Washington, D. C.; and these men kept in close touch with the construction to observe the results obtained. The fol-

lowing information is abstracted from a report prepared by them and presented at the recent annual convention of the American Concrete Institute in Chicago.

The operation of the specification was closely observed and a regular program of tests was carried out. The compressive strength of the concrete was determined at 3, 7 and 28 days in 6x12-in. cylinders, taken each day from several batches immediately before they were deposited. Frequent determinations of sieve analyses and of moisture content of the aggregate were made throughout the work.

Water-Ratio and Tolerance—Concrete for structural members was proportioned to give the necessary workability *without exceeding* the following ratios of water to cement: (1) for 2,900-lb. per sq.in. concrete, 6 U. S. gal. of water per sack (94 lb.) of cement; (2) for 2,000 lb. per sq.in. concrete, 7½ U. S. gal. of water per sack (94 lb.) of cement.

The contractor was not restricted in the type of equipment for measuring or handling since it was comparatively easy to keep the ratio below the maximum.

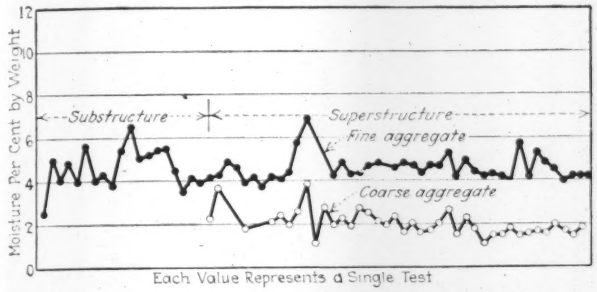


FIG. 3—MOISTURE CONTENT IN AGGREGATE
Note how slight the variation is, 90 per cent of the values falling between 3.5 and 5.5 per cent.

Equipment Used for Measurement of Materials—The aggregates were stored in small stockpiles on the street pavement. For the substructure they were measured in wheelbarrows, while buggies were used for the superstructure.

In the caisson work, the water was measured in a closed tank directly connected to the city water supply and equipped with a check valve which closed when the tank was filled. Water entered the tank and was discharged through a 3-way valve, the quantity discharged being regulated by means of a movable pipe. Owing to the inherent deficiencies of this style of tank, this device was not particularly satisfactory and it was necessary to make considerable allowance to insure that the specified water ratios were not exceeded.

For the superstructure, the water-measuring device consisted of a calibrated open tank provided with an adjustable overflow pipe which prevented more water being let into the tank than was required for the batch. This device permitted quite accurate measurement of the water, but corresponding accuracy was not obtained in the case of the aggregates which were measured in the buggies in fractional quantities. It was necessary, therefore, to set the water container so that with the largest quantity of aggregate in any batch, the specified water-ratio was not exceeded. For those batches with smaller quantities of aggregate, a water-ratio below the specified amount was obtained, and this fact showed up in many of the strength tests.

The provision in the specification concerning uniformity of grading during each day's operations would likely be important in many cases. Little difficulty was encountered in this work from variations in grading but the few occasions when the grading did vary showed the importance from the contractor's point of view of having uniform materials in order to avoid frequent changes in the proportions. The moisture content of the aggregates did not vary greatly. The greatest range between two successive determinations for the sand was 2.6 per cent, the usual range being less than ½ per cent. The experience on this building and other considerations indicate that under favorable conditions as to the source of materials and facilities for storage, difficulties occasioned by the amount of water carried by the aggregate may never be realized.

Comparative Advantages in Using This Specification

Quantity of Cement Used—Concerning the probable effect of the water-ratio specification on the amount of cement required, the results from this building were most reassuring. In the caissons the average cement factor was 1.17 bbl. per cubic yard for concrete showing a strength of 2,880 lb. per sq.in. The contractor reported that this cement factor was about 1 sack per cubic yard less than his usual practice for this class of work. This saving was obtained through the use of consistencies much stiffer than is the usual practice and comparatively large aggregate, the maximum size of which was 1½ in. In the superstructure, the average cement factor was 1.47 bbl. per cubic yard.

Workability and Proportioning of Aggregates—The proportions of aggregates were governed solely by the requirements of workability with the single limitation that the coarse aggregate should not be less in amount than the fine, nor more than twice the fine. Workability was limited by the requirement that the mass could be puddled readily into the corners and angles of the forms and around the reinforcement. Maximum slumps were specified for different portions of the building as follows:

	Maximum Slump
Caissons	4 in.
Heavy walls, slabs and beams	7 in.
Thin walls and columns	9 in.

In this connection it must be remembered that within the limits of truly workable mixes the slump test has its most useful application, but that it is not intended to recognize the slump test as an absolute measure of workability. On the basis of slump, the workability of mixes of wholly different proportions or of different kinds of aggregates is quite absurd. Under conditions of uniform operation the slump test can be useful in indicating any change in the character of the materials, the proportions

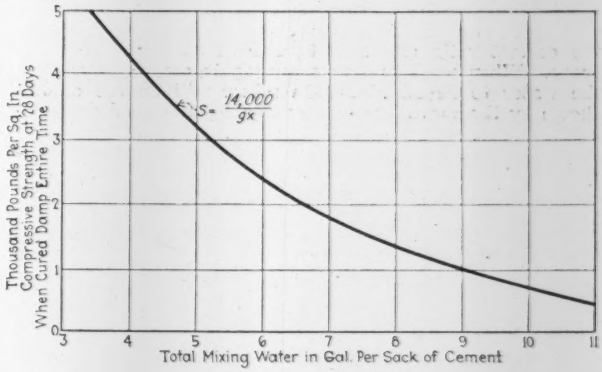

Thousand Pounds Per Sq. In. Compressive Strength at 28 Days When Cured Damp Entire Time
S = 14,000 / 9x
Total Mixing Water in Gal. Per Sack of Cement

FIG. 4—CONCRETE PROPORTIONING CURVE FOR SMALL JOBS
Note 1: By "total mixing water" is meant water in the sand and stone plus that added at the mixer. Note 2: Very wet sand will contain from ¾ to 1 gal. per cu.ft. Moderately wet sand will contain about ½ gal. per cu.ft. Moist sand will contain about ¼ gal. per cu.ft. Moist gravel or crushed rock will contain about ¼ gal. per cu.ft. Note 3: The coarser the sand the less water it will carry.

or the water content, as the test is very sensitive to such changes. It may not indicate which of these elements is the disturbing factor, but at least it shows the operator that some change has taken place and he can make the necessary investigation and corrections.

On the job there was no occasion for argument over the consistency of proportions and the old argument as to the amount of mixing water was entirely lacking. This fact is interesting when it is recalled that the tendency for the caisson concrete was all toward the use of consistencies approaching the limit of stiffness, while the concrete in the superstructure tended toward the opposite extreme.

Proportioning—In the specifications for the Portland Cement Association building, the limits established as to proportions of coarse and fine were that the ratio of the coarse to fine should not be less than 1 nor more than 2. It may be objected that this rather liberal margin is not in accord with the generally accepted notion that aggregate proportions should be adjusted to give the densest possible

mix or the largest possible proportion of coarse material consistent with proper workability. However, while it is true that denser mixtures and, under a certain very limited range of prices, more economical mixtures can be obtained by the use of larger proportions of coarse material, the gain in these respects is so slight as to make it undesirable to attempt such mixes at the risk of honeycombed structures or greater cost of placement. There is very little likelihood of overharsh mixes being used because, with the usual range of prices, they do not prove economical even neglecting the extra cost of placing. Since there is little to be gained through the use of mixes low in sand content and much to be avoided, no objection can be raised to the specification of a maximum proportion of coarse aggregate.

From the foregoing considerations it will be seen that under the water-cement ratio specification the interests of the contractor and the owner are more or less identical. The mixes, which the contractor finds economical, will avoid honeycombing on the one hand and excess water and its consequent porosity on the other.

Adaptability to Small Jobs—At the same convention of the American Concrete Institute Mr. McMillan also presented the following explanation of how to apply this method of concrete proportioning to a small job. The curve which accompanies the explanation, Fig. 4, is the lower of the two water-cement ratio curves proposed by Abrams and Walker. This one, instead of the higher one in Fig. 2, is to be used where the conditions of construction and inspection are not so assured as on a large, well-manned job. The instructions as to using the curve are as follows:

To get concrete of any desired strength, select from the curve in Fig. 4 the amount of mixing water to use for that strength.

Then mix sand and stone as desired until the required consistency or workability is obtained, using all the time the correct ratio of water to cement as found from the curve. When sand or coarse aggregate contains moisture, the water to be added at the mixer will be the amount shown by the curve less that carried by the sand or coarse aggregate as indicated in Note 2.

The more aggregate that can be added to a given quantity of cement and water, the more economical the concrete, the limit being that the mix must not be too dry or harsh to place readily.

Illustration: If concrete having 1,800 lb. per sq.in. is desired, the curve shows that the total water required is 7 gal. per sack of cement. Suppose moderately wet sand and dry crushed limestone were to be used. A first batch should be made up, say, using 1 bag cement, 2 cu.ft. sand and enough coarse aggregate to produce required consistency. Two cubic feet of sand as per Note 2 would carry a total of 1 gal. of water. Therefore, it would be necessary at the mixer to add 7 — 1 = 6 gal. If it were found desirable to use more or less sand to get the desired workability, say 2½ cu.ft. of sand, then the correction would be 1¼ gal. and water to add at the mixer = 7 — 1¼ = 5¾ gal. for each bag of cement.

Organization—The design of the building and the supervision of the construction was in the hands of Holabird & Roche, architects, Chicago. The general contractor was the Turner Construction Co., New York City, and the caisson work was sublet to the Mid Continent Construction Co., Chicago.

No More Right Turns at Trafalgar Square

The circulating traffic law for Trafalgar Square, London, effective April 26, to relieve congestion at that point, like the "No left turn" method used at many American traffic centers, requires that all vehicles entering the square keep to the left, dropping out at the desired street. If necessary, a car must go completely around the square rather than make a right turn. The traffic count showed as high as 4,500 vehicles an hour making use of this scheme.

Decatur Sewage Pre-aeration Experiment Triples Filter Rate

RECENT experiments at Decatur, Ill., on city sewage consisting largely of starch wastes indicate that by the use of a Simplex aerator Imhoff tank effluent can be handled at the rate of 3.24 m.g.d. per acre against a third that rate without aeration. On a population basis the corresponding rates per acre would be 90,000 and 30,000 persons respectively. The following notes are taken from a paper by R. G. Rankin, with Pearse, Greeley & Hansen, consulting engineers for Decatur, presented recently to the Engineering Society of Wisconsin.

The main sewage-works at Decatur treat a very strong sewage consisting of the domestic sewage of 50,000 population and industrial waste from the starch works which varies with the grind and may have a population equivalent of 300,000 on a biochemical oxygen demand basis, making a total of 350,000. The existing Imhoff tanks and trickling filters were designed to handle a flow of 8 m.g.d. from a population of 60,000. The first installation was not expected to handle all of the starch-works waste. Both of these plant elements have operated successfully at rates considerably in excess of the designed rates, but the rapid increase in the industrial load has made enlargements to the plant very necessary.

During the first five months of the operation of the testing station a large volume of condenser water from the starch works diluted the sewage. Even with this dilution, the actual volume of sewage treated at the plant had an average 5-day biochemical oxygen demand of 460 p.p.m. Considerable trouble was experienced in making the light fluffy semi-activated sludge settle. A larger settling tank was installed which gave periods of settling as high as four hours, and although the sludge settled better, light sludge still came over the weirs very occasionally.

It was thought that more complete aeration with a larger percentage of activated sludge returned might give a thicker and better settling sludge. The aeration period was varied from 3 to 7 hours and the sludge returned from 16 to 55 per cent by volume of the inflowing sewage. Re-aeration was varied from 0 to 3 hours and the air for re-aeration from 0 to 3.5 cu.ft. per gal. Increase in aeration and large sludge return were found to aggravate settling conditions. The best condition was obtained with an aeration of about 3 hours, no re-aeration of the returned sludge and a sludge return of 8 to 13 per cent by volume. At these rates of operation, the sludge has settled uniformly well.

During this five-month period of operation, the trickling filter rate was slightly over 3 m.g.d. per acre. Even though the effluent from the settling tanks continued at times considerable light fluffy sludge, the filters effluent was good and the settled filter effluent stable. During this same period the large trickling filters of the main sewage plant were forced somewhat at a rate of 1.25 and 1.5 m.g.d. but at these rates, pooling resulted. There was no pooling of the experimental filter at the rate of 3.3 m.g.d.

The sewage from the Imhoff tanks as applied to the main trickling filters contained an oxygen demand of 5,000 lb. per m.g. (600 p.p.m.) and that from the pre-aeration settling tanks as applied to the test filter contained 2,560 lb. per m.g. (319 p.p.m.).

Massive Reinforced-Concrete Church in Los Angeles

Design Details of Structure with Extreme Length of 251 Ft. and Height of 150 Ft.—Tower Dome Gunited

By G. H. Schulte
Albert C. Martin, Architect, Los Angeles, Calif.

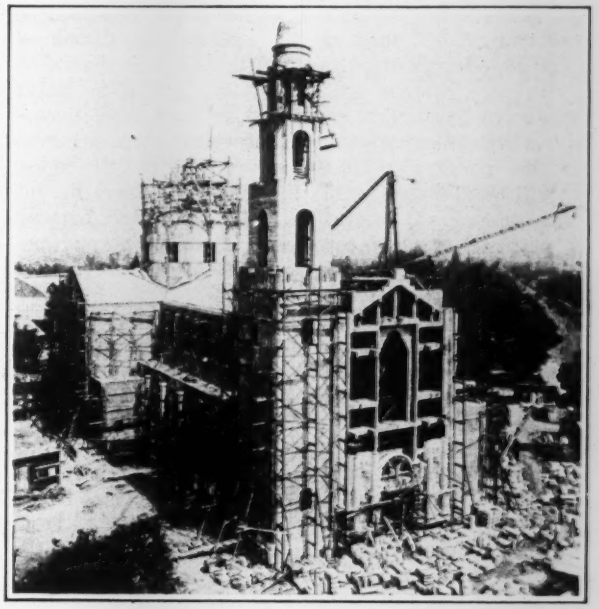
INTERESTING problems of design and construction were involved in the new St. Vincent Church built in Los Angeles. The building is Spanish in design with tile roof and cement stucco walls trimmed with Indiana limestone. It is set diagonally on the property with the main entrance and tower facing the street intersection. The extreme length of the building is 251 ft. 5 in. with a width at transepts of 110 ft., while the tower is the limit height of 150 ft. allowed by the local building code.

The floor plan consists of the narthex and nave with side aisles, of two transepts with a domed crossing between, of the sanctuary and various chapels, sacristies and baptistry. The floor of the nave and of the center portion is on fill. The area under side aisles, the narthex, and the ends of transepts, is excavated and serves as pipe and duct space, forming a passageway leading to the boiler and transformer rooms and various service rooms located in the basement under the sanctuary. Structurally the building is a Class A, reinforced-concrete skeleton, with concrete filler walls. Its size and shape and the massive sections required by the type of architecture selected, called for an unusual amount of engineering design and detail.

Before preparing plans, test pits were dug at various points on the property and showed a uniform condition of sandy gravel occurring from 3 to 6 ft. below the surface. The foundations were designed for a soil bearing value of 3 tons per square foot, with all footings at least 7 ft. below the natural surface. They are in general of square or rectangular shape except those under the tower. This is supported on four wide reinforced-concrete beams in order to distribute the load properly with reference to its center of gravity. The footings supporting the nave and side aisles are tied together to insure equal settlement.

The nave roof, which is 63 ft. 7½ in. above the main floor at the center, is supported on six reinforced-concrete frames spaced 17 ft. on centers. These were designed as stiff frames. The moments occurring at the intersection of the aisle roof and nave columns were distributed into the lower nave columns, aisle girders, and aisle columns in proportion to their respective lengths and moments of inertia. The arches between the nave and aisles carry only the roof of the side aisle and the load of light filler walls. There are wide shallow beams above and below the clerestory windows to carry interior and exterior filler walls, thus providing the deep embrasures and splayed window openings required by the design. The roofs of the nave and side aisles are concrete slabs carried on reinforced-concrete purlins, which are left exposed and plastered and decorated. The clay roofing tiles are hung from copper furring bars fastened to the roof slab with wires set in the concrete for that purpose. The nave columns are rectangular, with a concrete section 3 ft. 4 in. wide by 2 ft. 6 in. deep. The aisle columns have an extreme depth of 6 ft., 3 in., of which 30 in. forms the architectural buttress, 8 in. is occupied by the reinforced-concrete exterior wall, and the other 37 in. forms the recesses for the confessionals. The main entrance into the narthex is through a massive arched opening. This effect is obtained by using wide rectangular columns supporting beams on each face, which carry the inner and outer filler walls. The entire stone façade on either side of the opening is carried on a heavy cantilever slab at the main floor level.

The tower measures approximately 20 ft. square at the base and maintains this section for 72 ft. 7 in. Above this point it rises in four decreasing stages to a total height of 150 ft. Of the four corner columns carrying the first stage, the outer one is unsupported for a length of nearly 40 ft. except for ties of heavy reinforcing bars that are placed in the 8-in. concrete filler wall at intervals of 10 ft. At the top of the first stage there is a square frame of four large beams which support the eight columns of the smaller second stage which is also square in section. The third and fourth stages are octagonal in shape and the eight columns of each are carried on diagonal beams supported



REINFORCED-CONCRETE CHURCH IN LOS ANGELES

on the columns of the lower stage. The last stage is a concrete cupola which is octagonal on the inside but has a circular surface with outside diameter of 10 ft. at the base. It is of gunite with a minimum thickness of 3 in.

The crossing formed by the intersection of the nave and sanctuary with the transepts is approximately 43 ft. square; four large cross-shaped columns at the corners support reinforced-concrete arches, hinged at the crown. Short concrete posts from these arches carry beams arranged in the form of an octagon. Above this frame are smaller rectangular columns with a continuous wide ledge at the top at an elevation of 84 ft. 2½ in. above the nave floor. On this ledge is carried the hemispherical concrete dome 43 ft. in diameter surmounted by an octagonal concrete lantern 11 ft. 4 in. in diameter and 19 ft. 7 in. high.

The dome is designed for a wind load of 30 lb.

Dead-load includes the weight of plaster and furring on the inside, Mexican glazed tile on the outside, and a heavy concentration for the lantern and its carved stone facing.

The dome is 3¾ in. thick at the base and 3 in. at the edge of the lantern ring. In order to distribute the load of the lantern over a larger circumferential area of the dome, eight shallow concrete ribs were introduced on the underside of the shell, starting at the edge of the ring and extending out about 8 ft. to a point where they intersect the curved surface. Solid forms were built and covered with building paper and all reinforcing was placed and wired securely. Concrete was then applied with the cement gun with a resultant hard, regular surface. Considerable care was used in the curing of this thin shell which was covered with burlap and kept constantly moist for ten days.

The problem of acoustics in a building of this shape and size also required consideration. Solid concrete surfaces might cause excessive reverberation and the plan of the building is such that annoying echoes were to be expected unless precautions were taken to prevent them. For this reason it was decided to line all large surfaces with some material that will absorb sound instead of reflecting it. The ceiling panels of the nave and transepts and the interior of the dome are therefore covered with acoustical felt. The latter is protected by a dust cloth and covered with perforated canvas, the purpose of the perforations being to allow the passage of sound waves to the felt where they will be absorbed, and still permit the carrying out of the scheme of decoration. All walls are covered with artificial travertine which is a highly porous material and should prove very satisfactory in preventing echoes and reverberation.

Working conditions at the site were ideal as the contractor had the use of the entire lot 250 ft. x 350 ft. and access from two streets. He was able to lay out his plant to the best advantage. The concrete hoist and mixer were placed on the south side of the building in the corner formed by the intersection of nave and transept. Nearly all the concrete was handled from this point by chutes. The cement shed nearby had a capacity of several carloads, and was equidistant from the storage piles of sand and crushed rock from the mixer; material was delivered by motor truck and carried to the mixer in wheelbarrows. Reinforcing bars were fabricated and carefully segregated and racked at the site. A complete woodworking plant was installed at the rear of the property and all formwork was detailed, built and assembled there.

The shoring to support the heavy masses of concrete involved careful work in its design and erection. The arched beams over the nave had to be supported from the nave floor slab, which was poured on filled ground. To distribute this load, long 12x12-in. timbers were laid on the nave floor and the shoring erected thereon. The resulting structure justifies the careful effort that has been made, as there are no appreciable bulges and all edges and planes are plumb and true. All concrete, except for slabs on fill, was mixed in the proportion of 1:2½:3½ as required by the local building code, and the finished product is particularly dense and free from honeycomb. There were used in the structure 7,500 bbl. of portland cement, 250 tons of reinforcing bars, 600 thousand common brick, and 350,000 ft. b.m. of lumber and shoring.

All plans, architectural, structural and mechanical were prepared in the office of Albert C. Martin, architect, who also had responsible charge of the design and installation of all fixtures and of the interior decoration of the building. The Wurster Construction Co. was the general contractor, under the supervision of the architect.

Current Reclamation Work

AN expenditure of $25,000,000 is involved in current federal reclamation work. The largest items are three dams, but other work of importance is also included.

McKay dam, Umatilla project, begun 1923, is nearing completion. It is located on McKay Creek, 8 miles south of Pendleton, Ore., and is an earth and gravel-fill dam of 160-ft. maximum height, length about ½ mile, volume about 2¼ million cu.yd., storage capacity 75,000 acre-ft. for supplemental supply to 30,000 acres near present Umatilla project; cost $2,250,000.

American Falls dam, a concrete gravity structure 87 ft. high, 3,100 ft. long, 170,000 cu.yd., with flanking embankments 1,900 ft. long, will form a storage reservoir of 1,700,000 acre-ft. on the Snake River at American Falls, Idaho, to supply additional water to a number of irrigation projects down the Snake River and to irrigate 115,000 acres of new land just north of the Minidoka project. Construction begun a year ago by Utah Construction Co. Power developed at the dam will be largely used in pumping irrigation water on the north side of Minidoka project. Total cost, $8,000,000.

Guernsey dam, on North Platte River, 2 miles above Guernsey, Wyo., will be an earth and rock-fill structure 97 ft. high, 575 ft. long, forming a storage reservoir of 72,700 acre-ft. to increase the water supply for the North Platte project by equalizing the irregularities of river flow due to the great distance of the main storage dam (Pathfinder dam) from the project. Cost about $2,500,000. Contractor, Utah Construction Co. Power output 2,500 kw. Work begun during the past year and contract about one-third completed.

Power plant for Yuma project, 1,200-hp. capacity, at drop in California main canal; cost $250,000; will furnish power for pumping to Yuma mesa lands. Erection of power house is in progress.

Canal construction and enlargement on North Platte project are under way, to cost $465,000. The Interstate Canal, watering the north side lands, is being enlarged and the Laramie River diversion canal, on the south side, is being built. Concrete canal lining on the Carlsbad project and drainage and miscellaneous work on the Rio Grande project, now in progress, will cost something more than $1,000,000 when completed.

Canal construction on the Kittitas division of the Yakima project is about to begin; specifications now being prepared for early letting of contracts. About 27 miles of main canal are involved. Estimated total cost, $7,500,000.

Canal and embankment work on the Riverton and Shoshone projects, Wyo., is under way and will cost $479,000 when completed. It includes construction of the Pilot Butte dam embankment, 42 ft. high, 2,400 ft. long, on the Riverton project, and construction of canal and laterals on the Willwood division of the Shoshone project.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

St. Louis Engineers Defend E. E. Wall

Sir—The communication of C. E. Smith in your issue of April 15, 1926, p. 622, concerning the removal by the mayor of E. E. Wall from the position of director of public utilities of the city of St. Louis is intended to influence the judgment of the profession.

It may contribute to understanding of the situation to note that Mr. Smith is an employee of the city of St. Louis, as consulting engineer. With this in view, some paragraphs of his letter are clarified.

Not being a member of the Board of Public Service, and therefore not in attendance upon executive sessions of the board when decisions are reached, Mr. Smith is hardly in position to speak concerning Mr. Wall's failure of co-operation. On the contrary, Mr. Wall's 34 years of unbroken service (under eight mayors) rendered the city should be sufficient answer to any newly developed charge of incompatibility.

The mayor's original issue with Mr. Wall was a demand to discharge a competent chief electrical engineer and to replace him with a practical man, not an engineer. Later the mayor admitted the competency and honesty of the chief electrical engineer and exonerated him of charges against him.

Sec. 5 of the charter of the city of St. Louis reads: "Each head of a department, office or division shall be responsible for the acts or omissions of officers and employees apointed by him, and may require bonds or other securities from them to secure himself."

It was, therefore, clearly an assumption of power not properly his, for the mayor to demand appointment of an individual who must be responsible to the head of the department.

It has been the pride of St. Louis for many years that the engineering part of its city government has been honestly and competently conducted. The mayor's recent action is all the more to be regretted in that it may be the beginning of a change which can only end in disorganization, if nothing worse.

We seek no controversy in your columns, but reply to testify our appreciation of Mr. Wall, in regret that the mayor should take such action, and Mr. Smith defend it.

ARTHUR THACHER, A.I.M.M.E.
BAXTER L. BROWN, A.S.C.E.
ARTHUR S. HAWKS, A.S.M.E.
ROBERT GARRETT, A.S.C.E.
F. W. GREEN, A.S.C.E.
GEORGE E. WELLS, A.S.M.E.
E. B. FAY, A.S.C.E.
GEORGE E. CHAMBERLIN, A.I.E.E.
H. H. HUMPHREY, A.I.E.E.
JOHN J. LICHTER, A.S.M.E.
JOHN HUNTER, A.S.M.E.
PHILIP N. MOORE, A.I.M.M.E.
JOHN GARRETT, A.S.C.E.
C. D. PURDON, A.S.C.E.
CARL GAYLER, A.S.C.E.
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H. A. WHEELER, A.I.M.M.E.
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E. J. SPENCER, A.S.C.E.
E. B. FAY, A.S.C.E.
A. O. CUNNINGHAM, A.S.C.E.
E. R. FISH, A.S.M.E.
JOHN GARRETT, A.S.C.E.
F. C. WOERMAN, A.S.C.E.
H. F. ROACH, A.S.C.E.
JOHN A. LAIRD, E.C., St. Louis

St. Louis, Mo.,
April 24, 1926.

A Large Caisson Cofferdam Without Temporary Bracing

Sir—I have read with much interest C. S. Proctor's excellent article in *Engineering News-Record* of April 15 (p. 598) on the problems of the deep caisson cofferdam of New York Federal Reserve Bank; and because the subject has never been presented in print, except in the briefest reference, and because the final results attained were similar but obtained by a totally different process of construction, I beg to suggest for brief consideration the experience of the Hudson & Manhattan R.R. in building its terminal station at Church St., New York, between Cortlandt and Fulton Sts., which at the same time provides the foundations for the Hudson Terminal Buildings. This work was carried out during 1906 and 1907. The part concerned with the building foundations was originally let by contract, but after a few months was taken over by Hudson Companies —then the construction agency of the railroad—and executed by its own forces, who also constructed the adjacent switch enlargements and approaches, also built by the caisson method, occupying the entire width of Cortlandt and Fulton Sts. from Church St. to Greenwich St.

The site of the station extends 435 ft. along Church St., including Dey St., and has a width of 170 ft. on Fulton St. and 178 ft. on Cortlandt St. Since at Greenwich St. the top of the tubes had to be kept 20 ft. below street surface to permit the later construction of the west side Interborough subway, it was necessary to place the track floor of the terminal 14 ft. 6 in. below M.H.W. Obviously it was necessary to reserve the entire floor above the railroad platforms for distribution of passengers, and consequently the electric sub-station, air compressors and other equipment for railroad operation, as well as all the plant (1,800-hp. boiler plant included) necessary for operation of the buildings had to be placed below the track floor.

In anticipation of completion of the buildings, contracts for rental of offices were made on guarantee of early completion. Speed was therefore essential. The construction plan provided for a watertight caisson dam wall around the entire area. The walls occupying the Church, Cortlandt and Fulton St. fronts were set out under the streets, and lines of columns were located along the building line to carry the exterior walls of the building itself. The street surface average El. 322 (22 ft. above mean sea level); open excavation was carried down to El. 308, while ground water was at El. 307. The sides of this open excavated pit were supported by sheeting and timber. The caisson dam walls, which it was essential should be watertight when completed, were 8 ft. thick. Wood box forms were used and the joints were fitted with halfmoon recesses for final sealing.

The main dam, enclosing an area of 67,500 sq.ft., comprised 51 caissons, the first commenced July 31, 1906, and the last completed July 17, 1907. The actual excavation under air pressure in these 51 caissons was 25,566 cu.yd. All these exterior dam caissons were sunk through hardpan and sealed on bedrock, which averaged 78 ft. below street level; although a maximum depth was attained of 110 ft. from street to rock. Generally the concrete seals between caissons were watertight after pressure grouting, but for the joints along the Church St. front and other joints which indicated seepage a channel section of steel was driven outside of the joint, sand-pumped clean and then calked and grouted. This made the dam practically bottle-tight without any internal treatment.

In order to ensure completion of the foundations to permit building erection to proceed, the plan was adopted of sinking pits under air pressure at the interior column locations, to permit placing the column foundations before completion of the exterior dam. For this purpose 32 rectangular and 115 circular caisson shafts were sunk, the first started Dec. 22, 1906, and the last completed May 24, 1907. All of these employed wooden form boxes, which were later cut to pieces as the general excavation was carried down. The total excavation under air pressure in these interior caissons was 26,104 cu.yd.. As each of these interior shaft caissons was sunk and sealed, the permanent column footings were placed in the pit bottom; air pressure was then removed, the pit opened up, and the permanent building column erected up to the street level floor. By the time the exterior dam wall was completed and sealed, all the building columns were erected in place,

though the general excavation surface within the cofferdam still remained at El. 308.

The complete steel framing of the street floor was then erected, bracing all columns at that elevation. Immediately on closing the dam wall the excavation of the internal area was carried down to what is now the concourse floor, and that steelwork erected, wedged tightly to the dam wall and concreted, providing permanent support of the dam without any internal timber whatever.

Then the excavation was carried on down to the under side of what is now the track floor, which was designed to be the main element in withstanding all exterior pressures. Owing to the probability of vibration from train operation being transmitted to the building structures and owing to the difficulty of placing and erecting an ordinary steel floor, it was decided to place only the very deep main plate girders for this floor and to make the floor itself very massive, consisting of a solid continuous slab of heavily reinforced concrete over the entire area from wall to wall of the cofferdam, having uniform thickness of 3 ft. with only such openings as were necessary and essential to give permanent access to the basement floors. This has proved absolutely efficient.

Following this floor construction, the remainder of the excavation was taken out to the bottom. Over the general area the basement floor is at El. 269; the boiler rooms and bunkers are considerably deeper, and the electric power substation extends down to 77 ft. below street level, at El. 249.

The total excavation taken out in open air was 132,570 cu.yd., while that under air pressure was 51,670 cu.yd. The substructure space within cofferdam is approximately 6,000,000 cu.ft.

Speed in completion of the buildings was of vital importance to the rental and occupancy of the office space, even before the railroad was in operation. The fundamental difference in method of construction between this and the work on Federal Reserve Bank was that there was elimination of the vast and intricate system of timber bracing of the dam walls, with all the hazards entailed in the use of timber by the substitution of column pits sunk under air pressure and the use of the permanent structure to retain the walls of the dam as excavation proceeded. The soil itself retained the dam until the permanent structure came into operation by taking its own pressure.

Further, I venture to think it probable that the unit cost of excavation after the pits were sunk, permanent columns and bracing erected, and the dam closed, was probably cheaper than if timbering to brace the dam had been carried on while excavation was in progress.

Simultaneously with the dam construction, it was necessary to construct the railroad switch enlargements and approaches. Under both Fulton and Cortlandt Sts. there have been constructed two tube tunnels below each street, leading out west to the Hudson River. In order to start these tubes, it was necessary to provide chambers for shield erection. All this work was at considerable depth below tide level, and in quicksand formation, necessitating use of air pressure and caisson construction. At the same time each street was so important to surface traffic that at no time could either be closed to traffic. The caisson construction was therefore carried on entirely below a temporary timber street deck, and the excavated material was taken out and supplies taken in from adjacent private property.

These caissons were made in sections, each of the full width of the street, of reinforced concrete with steel-shod cutting edge. The roof of the working chamber ultimately became the track floor, and above this level the caissons had only two permanent sides (of heavily reinforced concrete), as the two ends consisted of steel construction, removed after the next adjacent section was sunk. Under Cortlandt St. the invert and working chamber construction was very deep to permit the inclusion of very large ventilating ducts for permanent ventilation of the tunnels. The permanent roofs over these approach caissons were constructed on the side walls in sections as sinking was carried down. Cast-iron blocks were used to weight the caissons in sinking.

Owing to the fact that the approach work was under the streets, it could not be executed until the building cofferdam was far advanced. Trainway openings could not be provided in the cofferdam walls, but were cut through later.

The total displacement of air pressure caisson construction under these two streets, exterior to the cofferdam, was 24,730 cu.yd., so that the total caisson displacement for the entire work of the terminal foundations of Hudson Terminal and approaches is the amount of 76,400 cu.yd.

New York, N. Y., April 22, 1926. J. VIPOND DAVIES, Jacobs & Davies, Consulting Engineers.

Construction of Stress Distribution Diagrams

Sir—In the April 1 issue of *Engineering News-Record*, p. 537, in letters dealing with the graphical construction of stress distribution diagrams, certain methods are described. In the fourth edition of the American Civil Engineers' Handbook, p. 679, the construction given by Messrs. Hay and Schirmer is described and is indicated on Fig. 16-A. This edition was issued in 1920.

New York, N. Y., April 2, 1926. EUGENE E. HALMOS, Consulting Engineer.

Flood Probability

Sir—Your editorial Floods and Forests Again, *Engineering News-Record*, Feb. 4, 1926, p. 181, and letters from J. G. Sullivan, March 4, p. 374, and S. L. Meyer, April 8, p. 584, are of unusual interest.

The writer agrees heartily with your suggestion that forestation as a means of flood prevention is a fallacy. Likewise de-forestation on the watershed of the Red River of the North as a factor in determining the probability of future floods which Mr. Sullivan suggests seems somewhat of a fallacy.

Three factors more than any others determine flood probability: (1) Precipitation (rain or snow); (2) Temperature (in northern latitudes); and (3) "Concentration time" (mentioned by Mr. Meyer).

Carrying out the concentration idea it is found that floods along the lower reaches of large rivers occur when, and only when, high stages in the main stream coincide as to time with high stages in the principal tributaries.

Several features of flood probability along the Red River of the North at Winnipeg, Man., the location mentioned by Mr. Sullivan, are discussed in Bulletin 1017, "Drainage and Prevention of Overflow in the Valley of the Red River of the North," U. S. Department of Agriculture. On p. 52 this bulletin says: "Reliable records of floods since 1826 at Winnipeg, Man., are available. The extreme floods there occur in May. * * *, and are caused by fortuitous occurrence of high stages in the Red River and the Assiniboine River which joins the Red within the city of Winnipeg. The maximum flood recorded at Winnipeg crested May 22, 1826, about 15 ft. above the ordinary flood height in that locality. * * * The crest of the flood of 1882 in the Red River passed Winnipeg several days before that of the Assiniboine reached the junction of the streams; thus a greater flood was averted."

Snow as a flood producing factor is discussed on pp. 36 and 37 and by diagram, Fig. 15, on p. 38 of Bulletin 1017. The temperature factor is mentioned on p. 40. Investigations made in 1919 before Bulletin 1017 was compiled indicate the chances are remote that frequent high floods will occur at Winnipeg and yet the conditions still exist which may produce a flood as great as that of 1826 and every year which passes brings the time of such a flood that much nearer.

Possibly it may be true, as Mr. Sullivan suggests, that the works of man ("clearing of the lands and the construction of numerous drainage ditches") have decreased the danger of a ruinous inundation. However, nothing is more certain than that other works of man, as the building of a large city in the flood plain of a river, establish conditions through which the damage may increase immensely when an extreme flood occurs.

Precipitation, temperature, and time of concentration of runoff being unchanged on this watershed, the writer is inclined to believe that Winnipeg is no more secure from a great flood than were Dayton or Pueblo or Kansas City west bottoms prior to the floods at those places.

McGehee, Ark., April 12, 1926. P. T. SIMONS, Drainage Engineer.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Ontario Hydro to Buy Power in Quebec

Power Plants Being Built on Gatineau River—Long Transmission Line to Be Built

Premier Ferguson of Ontario has announced that the Ontario Hydro-Electric Power Commission has been authorized to enter into an agreement with the Gatineau Power Co., a subsidiary of the International Paper Co., for the purchase of from 230,000 to 260,000 hp. of hydro-electric energy at the Ontario - Quebec boundary near Ottawa, Ont., at a price of $15 per horsepower. Delivery will commence with a block of 80,000 hp. in 1928, the complete delivery to be made by 1931. The contract will be for 30 years, from 1928.

In order to provide adequate interconnection with the Niagara system of the Ontario Power Commission, the commision will build a high voltage transmission line from the point of delivery near Ottawa to a connection with the Niagara system near Toronto, a distance of approximately 230 miles. Construction of the transmission line will be commenced immediately. The estimated cost is between $10,000,000 and $15,000,000.

POWER PLANTS BEING BUILT

Work of the Canadian International Paper Co. now under way in the neighborhood of Ottawa, Ontario, includes a paper mill with a capacity of 500 tons a day and provisions for increasing the output at a later date, and two hydro-electric developments, one at Chelsea, Que., on the Gatineau River with a capacity of 73,400 hp. and, subsequently, a power development at Farmers Rapids, near Chelsea which will have a capacity of 51,700 hp. The first power development, the one at Chelsea, includes a dam across the Gatineau River at that point, with an over-all height of 109 ft. and a length, including the power house, of 1,600 ft. The head to be developed at this point is 96 ft. The power house will have space for four 21,000 hp. turbines, three of which will be put in for the initial installation.

The maximum height of the dam to be built at Farmers Rapids will be about 75 ft.

Recent unconfirmed reports state that the International Paper Company has purchased the Hull Electric Co. and the Hull Electric Railway Co., subsidiaries of the Canadian Pacific Railway, which companies own important power rights on the Ottawa River at Deschenes and on the Gatineau River at Paugan Falls.

CONSTRUCTION BY POWER COMMISSION

The Hydro Electric Power Commission also have under consideration the development of power at Chats Falls, on the Ottawa river, about 30 miles north of Ottawa. The making available of the 230,000 to 260,000 hp., along with the proposed development at Chats Falls, will, according to Premier Ferguson, assure the people and the industries of Ontario of an adequate supply of power for a considerable number of years.

Engineering Fifty Years Ago

From *Engineering News*, April, 1876

RAINFALL of the last of March was enormous, amounting in some places, to more than half the total rainfall of ordinary years. Disasters were frequent. Many dams yielded from increased pressure, and more from the shock of flood waters let down by the failure of reservoirs up stream. At Clinton, Mass., four large ponds of the Ware Mills broke away, March 26. At Burrillville, R. I., five dams, from Wilson's Reservoir to Oakland, gave way. On the Connecticut river, the east Haddam Buckle Co.'s dam failed. Two dams near Middleton, one at Rocky Hill, one at Durham Center, one at Salmon river, one each at Stourbridge, Danielsonville, Norwich and Lisbon were carried away. Some of these were small and slightly built, and some old and decayed.

Appropriations for Bridge Survey

The States of New York and New Jersey have each appropriated $50,000 for surveys, soundings, and borings for the Bayonne-Staten Island Bridge to be built by the Port of New York Authority.

$5,000,000 Terminal Warehouse to Be Built at Toronto

A large reinforced concrete terminal warehouse is to be built at Toronto, Ontario by the Toronto Rail & Harbor Terminal, Ltd. The building will contain 650,000 sq.ft. of dry storage and 225,000 sq.ft. of cold storage together with power house and ice making plants. It is to be built on the waterfront with adequate port facilities and will have rail connection with both the Canadian Pacific and Canadian National Railways. The warehouse will be the largest of its kind in Canada.

The estimated cost of the project is $5,000,000. The general contract has been let to the Parklap Construction Co., New York City.

New Standardization Body Agreed Upon

International Delegates at New York Plan Organization Composed of National Delegates

Unanimous agreement was reached last week by delegates from the national standardizing bodies of 18 countries, meeting in New York as the Third International Conference on Standardization, on the desirability of forming an international standardizing association, and on the general plan of organization of such a body. The name tentatively selected is International Standards Association. Its objectives would be to provide means of interchanging information on national standardizing work, to outline guiding principles for national standardization, to promote uniformity among different national standards, and to formulate and approve international standards.

MEMBERS FROM NATIONAL BODIES

Membership in the association would be held by the central national standardizing bodies of the different countries. Delegates from these bodies would form a plenary assembly, from which would be chosen a smaller administrative council. Technical committees of international makeup would work out the specific technical questions. Financial support would be provided by contributions of the different national bodies, computed in proportion to the country's foreign trade and population, in addition to a fixed amount per member.

A committee of seven was appointed to arrange for further international conference, for final ratification and organization. The tentative recommendation of the present conference was that London should be the seat of the new organization.

I.E.C. TO CO-OPERATE

Discussion between the delegates to the standardizing conference and delegates to the International Electrotechnical Commission, in session at the same time, considered the question of consolidating the latter with the proposed new body. On this point, however, a resolution adopted by the various groups of delegates to the International Electrotechnical Commission states that the I.E.C. has already received the formal recognition of many governments as an international means of interchange and promulgation, and that therefore the I.E.C. ought to offer its organization, facilities and experience for general international technical service of this character; this plan of operation, the resolution declares, would seem to afford the most direct, economical and safe approach to the eventual establishment of a comprehensive international technical commission.

Committee on Cast Iron Pipe Holds Organization Meeting

The organization meeting of the Sectional Committee on Specifications for Cast Iron Pipe and Special Castings, which has been formed under the auspices of the American Engineering Standards Committee to standardize cast iron pipe and special castings for all uses, noted in our issue of March 4, p. 375, was held at the Engineering Societies Building, New York City, on April 21 and 22.

The meeting was begun under the guidance of the four sponsor societies, namely, American Water Works Association, New England Water Works Association, American Gas Association and American Society for Testing Materials, through the agency of the so-called steering committee, made up of F. A. Barbour (A.W.W.A.), F. A. McInnes (N.E.W.W.A.), W. C. Morris (A.G.A.), C. L. Warwick (A.S.T.M.), chairman.

The sectional committee elected officers and an executive committee, adopted a set of rules for its own government, agreed upon a sub-division of the work of the committee between three so-called technical committees and appointed tentatively the members of these committees.

The following officers and executive committee were elected: chairman, Thos. H. Wiggin, consulting engineer, New York City, vice-chairman, N. F. S. Russell, president, U. S. Cast Iron Pipe Co., secretary, C. C. Simpson, Jr., general superintendent of mains and services, Consulated Gas Co. of New York.

Three technical committees were organized at the meeting. Committee No. 1 on dimensions, committee No. 2 on metallurgy, processes and tests, and committee No. 3 on corrosion and protective coatings.

$2,000,000 Soon Available for Hudson River Bridge

The New York State Legislature, before it adjourned, approved a bill appropriating $1,000,000 toward the construction of an interstate bridge across the Hudson River at New York City, and at the same time made provision for a like amount for the next five years. The bill lacks only the Governor's signature to become law.

In order to get around a provision of the New York State Constitution that no appropriation of state funds may be made for a longer period than two years and still keep faith with the State of New Jersey, which has appropriated $5,000,000 to become available in five annual installments of $1,000,000 each, conditioned upon New York State doing likewise, the bill contains an agreement on the part of the State of New York with the State of New Jersey, to provide and make available, subject to the limitations and conditions of the bill, the sum of $5,000,000, the State of New York reserving to itself the right to determine whether such sums shall be provided out of appropriations or from tolls from the vehicular tunnel.

Fusion Welding Problems Under Discussion

American Welding Society Meets—High Temperature Strength of Welds To Be Studied

At the meeting of the American Welding Society held at New York last week (April 21-23), progress in fusion welding practice was set forth in a number of technical papers and plans were discussed for further development of knowledge and improvement of practice. One of the interesting research items reported was the announcement of the San Francisco Section that a research on the strength of fusion welds at high temperatures is shortly to be started, the University of California and Leland Stanford University co-operating.

In the same connection representatives of the Boiler Code Committee of the American Society of Mechanical Engineers discussed the attitude of that committee with respect to its unfired pressure vessel code, which places limitations on fusion-welded connections. The explanation given is that while the committee realizes that good welding can be done, it feels it necessary to refrain from sanctioning practices not yet universally accepted as safe and conservative. The subject of welds for pressure vessels was briefly dealt with in several technical papers.

Details of electric welding practice were brought to the front in a summary of a long series of comparative tests made several years ago, reported by H. L. Warner, General Electric Co. The apparent indication of the tests is that a V-angle of 60 deg. is best and that the strength of a single V-weld is as good as that of a double V-weld. Successful welding of non-ferrous metals was reported by a subcommittee, which told of welding aluminum and of the repair of turbine impellers by welding with prosphor-bronze rod. Welded pipe connections were also discussed, with special emphasis on the great flexibility of layout and installation made practicable by extensive use of gas-welded pipe connections.

At the meeting of the American Bureau of Welding, held in connection with the society's meeting, principal attention was given to outlining the present problems of welding in the fields of arc and gas welding, pressure vessels, and structural steel, the speakers being H. M. Hobart, S. W. Miller, H. L. Whittemore and J. H. Edwards. An experimental research into welded connections for structural steel is under contemplation, and the co-operation of steel structural interests in this investigation will be sought.

Agreement has been reached by the American Welding Society and the American Society of Mechanical Engineers to join in an elaborate investigation of welding for pressure vessels. This is intended to develop the information needed by the Boiler Code Committee and by designing engineers.

F. M. Farmer of the Electrical Testing Laboratories was elected president of the American Welding Society for the coming year, and E. M. T. Ryder first vice-president. The American Bureau of Welding elected Prof. C. A. Adams director, and W. Spraragen, secretary.

The technical papers read at the meeting included the following: L. J. Sforzini, "Design of Joints in Piping Installations"; J. W. Owens, Newport News Shipbuilding & Dry Dock Co., "Design of Joints in Ship Construction"; S. W. Miller, Union Carbide & Carbon Research Laboratories, "Design of Welded Joints With Special Reference to Pressure Vessels"; L. H. Burkhart, Struthers-Wells Co., "The Design of an Arc Welded Pressure Vessel"; A. C. Vick, Detroit Range, Boiler & Steel Barrel Co., "Design of Welded Joints for Tanks and Containers."

Western Society Conference on Highway Transport

Good papers on a well-selected list of subjects, but presented to disappointingly small audiences, characterized the spring meeting or convocation of the Western Society of Engineers April 21 and 22, devoted to highway and motor transportation. Only formal sessions for the presentation of papers were held, although at previous meetings lunch arrangements and round-table discussions have added to the social atmosphere and promoted informal discussion.

As a beginning, the development of the highway system of the United States was reviewed by Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, while Professor H. E. Riggs, University of Michigan, dealt with the classification and growth of highway traffic. Regulation and taxation of motor vehicles as common-carriers was discussed by Dwight Lewis, Iowa Board of Railroad Commissioners. Railway officials were present in good numbers to hear the subject of motor vehicles in relation to railway transportation presented by F. J. Scarr, Pennsylvania R.R. This referred more particularly to freight traffic, in which there is competition for short hauls, and it was pointed out by E. H. Lee (Chicago & Western Indiana R.R.) that the outcome will depend on the economy to both the railroad and the shipper.

Varying road widths, speeds and traffic intervals in relation to the traffic capacity of highways were discussed by R. F. Kelker, Jr., consulting engineer. Economic methods, financing of road construction and maintenance, and the safety aspect of highway traffic were dealt with by Professor Jacob Viner, University of Chicago, and S. J. Williams, National Safety Council, respectively. On the subject of economics of highway transportation, an array of facts and figures was given by Henry R. Trumbower, U. S. Bureau of Public Roads. Bus transportation as a comparatively novel factor was reviewed by M. B. Knox, editor of *Electric Railway Journal*, and some remarks on operating costs and the proper field for buses were given by H. E. Barber of the Egyptian Transportation Co., at Marion, Ill.

WASHINGTON NOTES

OF the bids made for the lease of the Muscle Shoals power and nitrate plants the majority of the joint congressional committee recommends acceptance of the joint bid of the Muscle Shoals Fertilizer Co. and the Muscle Shoals Power Distributing Co. as the most desirable. The latter company has been organized by a number of power companies in the southern states.

In reference to the recommendation Senator Deneen made the following statement for the committee:

"National defense is adequately served by this offer. The present plant or its equivalent in respect to capacity is to be maintained (until released by Congress) in its present state of readiness for the manufacture of explosives, the premises and personnel may be taken over by the United States whenever necessary in the interest of national defense, and a maximum amount of power is rendered available from the interconnected system for war industries.

"Agriculture is served by a definite program of fertilizer production.

"The Fertilizer Co. agrees to produce annually 40,000 tons of nitrogen in the form of concentrated fertilizer, by means of synthetic ammonia and phosphoric acid plants.

"A capital of $20,000,000 is provided by the bidder for this program of fertilizer production.

"The company agrees to limit the profits on fertilizer to eight per cent on cost.

"A Farmer Board of five members appointed by the Secretary of Agriculture shall regulate the sale and territorial distribution of fertilizer.

"The Fertilizer Co. has preferred use of all power generated at Muscle Shoals for the production of nitrogen and other fertilizer ingredients.

"The Muscle Shoals Power Distributing Co. guarantees the fertilizer performance of the Muscle Shoals Fertilizer Co. and agrees to surrender their power lease in event of forfeit in the fertilizer contract.

"In addition to insuring an economic program of nitrate and fertilizer production the bid provides the largest monetary return to the United States of any of the bids considered. First, with the properties as they now stand without further expenditures by the United States; secondly, they provide larger financial returns for increased power at both these properties due to upstream developments regardless of whether these latter are made by the United States or by other interests.

"The bid will return to the United States in the 50-year lease period the following amounts:

(a) For Dam No. 2 alone, but with primary horsepower increased by headwater storage developed by private interests within ten years.... $136,300,000

(b) For Dams No. 2 and 3 with primary horsepower increased by headwater storage developed by private interests within ten years.... $181,348,000

"The bid which the Air Nitrates Corporation, the other principal competing bid, offered for the Muscle Shoals properties a proposition which would return to the United States in the leased period $85,931,000, but this would involve the construction by the United States of Dam No. 3. The maximum offered by this bidder involving the building by the United States of Cove Creek Dam in addition to Dam No. 3 is $95,739,000.

"The bid recommended has an advantage in that it does not require additional appropriations by the United States involving the further expenditure of large sums of money on the Muscle Shoals property.

A FAVORABLE report on the Swing-Johnson bill has been made to the U. S. Senate by its committee on irrigation and reclamation. The report was made over the protest of Senator Ashurst (Arizona), who has filed an extended minority report. He contends that the bill proposes to raise revenue and for that reason must originate in the House, as provided by the Constitution.

The bill in present form provides for a dam at Boulder or Black Canyon on the lower Colorado River; for an all-American canal to supply the Imperial Valley; and for a power plant.

Secretary Mellon's suggestions for the financing of the project are embodied in the bill. A Boulder Canyon fund is set up in the treasury. The Secretary of the Treasury is authorized to advance to the fund up to $125,000,000 from which interest payments are to be deducted.

The Secretary of the Interior is authorized to make contracts for the sale of power at the switchboard and for water for irrigation and domestic uses. The dam and works are to remain the property of the government even after they are paid for by the beneficiaries.

Contracts for power are limited to fifty years. Renewals are to be made as provided in the Waterpower Act; conflicting applications also are to be handled along the lines of this act. Small agencies are to be permitted to share in the use of transmission lines. The Secretary in his discretion may lease the privilege of using the water discharged at the dam.

Approval of the Colorado River Compact is provided without waiting for ratification by the seventh state in the basin. Another section contemplates the making of a subsidiary compact by California, Arizona and Nevada. An authorization for investigations of the problems of the upper Colorado also is provided.

Senator Ashurst in his minority report declares the purpose of the bill is to coerce Arizona. He declares that a high dam at Boulder will prevent the development of the maximum resources of the stream and declares it to be "abysmal folly" to use 200,000 firm horsepower in the eternal task of raising water 1,730 ft. for use in southern California when adequate supplies can be obtained at no greater cost by diverting the water at Bridge Canyon. That dam with another at Glen Canyon, he claims, would allow the maximum use of the waters of the river.

Seventh Industrial Conference to Be Held in Penn. State College

The Industrial Conference, which the School of Engineering of Pennsylvania State College has been holding for a number of years, is to take place this year, May 14 and 15. This is the seventh of these conferences to which are invited a number of industrial leaders to discuss the problems of engineering training in its relation to industry. The conferences were initiated and have been carried on by R. L. Sackett, the dean of the School of Engineering.

This year there will be discussions on Helping High School Students to Understand What Engineering Is, by R. E. Doherty, of the General Electric Co.; Helping a Freshman to Find Himself, by Prof. C. L. Kinsloe; Helping the Senior to Find His Place, by George H. Pfeif, of the General Electrical Co., together with discussions on those subjects by professors in the college; a paper on the Economic Aspects of Transportation, by Howard Elliott, chairman of the board of the Northern Pacific Ry., and some discussions on selection and guidance by R. F. Carey, of the Westinghouse Electric & Manufacturing Co., Col. R. I. Rees, American Telephone & Telegraph Co., and W. E. Wickenden, director of the Engineering Investigation of the Society for the Promotion of Engineering Education.

Chicago River Project Advances

A final agreement of the several railroads and other interests affected by the proposed straightening of the Chicago River is another step made toward carrying out this important project, which will enable the city to open three or four more through streets to the southhern section and extend cross streets eastward as far as State St. The cost is estimated at $9,190,126, divided equally between land required and the construction of the new channel. Of this amount the city would pay $1,689,940, the remainder being distributed between the railways. Extensive changes will be necessary in railway terminals and yards and in city bridges. The agreement, which has been effected by a citizens' committee after protracted negotiations, now goes for approval to the council committee on railway terminals and then to the city council.

Major Jones Named for Member of Niagara Control Board

The Secretary of War has named Major DeWitt C. Jones, Corps of Engineers, as the representative of the United States on the Niagara Control Board, created by agreement between the governments of the United States and Canada for the purpose of obtaining closer co-operation between the two governments in the matter of controlling the amount of water diverted from Niagara River for generation of hydroelectric power. Major Jones recently succeeded Major Paul S. Reinecke as District Engineer at Buffalo, N. Y.

Electrotechnical Commission Completes Its Session

The International Electrotechnical Commission, which met in New York City for its annual meeting, April 13-22, brought the work of its advisory committees to a close in a plenary meeting on April 21. This is in line with the regular method of procedure of this organization, under which advisory committees in the commission, each committee acting under a definite assignment and being composed of representatives of the national committees of the country concerned or interested, hold sessions preceding the plenary session and then make their reports for action of the commission at the latter meeting.

In general, the work of the commission is to bring into accord the electrical terms used in various countries. Recently it has entered the field of civil engineering through the work of its committee on prime movers which is studying the definition of terms in connection with the development of hydroelectric power. Among the questions approved for submission to national committees was the suppression of "horsepower" as a symbol in hydraulic measurement and the substitution of "kilowatt."

Tunnel Cave-In Imprisons Six—Five Killed

Six men working at the face of the heading of the tunnel being driven for the Buck's Creek hydro-electric project in California were imprisoned on April 17 when tunnel timbering was crushed and 42 ft. of the tunnel adjacent to the heading collapsed. Rescue crews working at top speed in short relays were hampered by some further slipping of heavy ground but succeeded in reaching and bringing out alive one of the entombed men, sixty-eight hours after the cave-in. A few hours later bodies of the other five were recovered.

The tunnel which is being driven for the Feather River Power Co. under subcontract to Fontaine & Dardier, is indicated as No. 1 in the map of this project, published in *Engineering News-Record*, Dec. 17, 1925, p. 1009. The tunnel is 7 ft. wide by 8 ft. high and a length of 136 ft. had been driven when the collapse occurred.

Goodnough Favors Ocean Outfall for Los Angeles County

A report endorsing ocean disposal and approving in general the entire sewerage plan for the County Sanitation Districts of Los Angeles County, Calif., was filed with the directors of the districts on April 6 by X. H. Goodnough, consulting engineer, Boston, and engineer of the Massachusetts State Department of Health. Mr. Goodnough declares that in his opinion "the Metropolitan area of Los Angeles should adopt no other plan than that of disposing of the sewage into the sea." The plan was outlined in *Engineering News-Record*, June 18, 1925, p. 1026. A. K. Warren, Los Angeles, Calif., is chief engineer of the districts named above.

East Bay District Granted Rights to Mokelumne Water

The California Division of Water Rights on Apr. 17 approved the application of the East Bay Municipal Utility District for the right to divert 200 m.g.d. from Mokelumne River for the use of cities on the east side of San Francisco Bay. The decision involves points of law upon which the division has not hitherto been required to pass, and is regarded as of importance in the matter of precedent. At the hearings held jointly before the Division of Water Rights and the Federal Power Commission, which were concluded last October, there were appearances on behalf of some 350 interested parties and the transcript, exclusive of briefs, comprised six volumes with a total of 2,040 typewritten pages. A report of the situation at the conclusion of the joint hearings was published in *Engineering News-Record*, Nov. 19, 1925, p. 851 The power commission has not yet announced its decision.

An important point in the decision of the Division of Water Rights is the interpretation of that section of the Water Commission Act which provides that "the application for a permit by municipalities for the use of water for said municipalities or the inhabitants thereof for domestic purposes, shall be considered first in right, irrespective of whether they are first in time; provided, however, that such application for a permit or the granting thereafter of permission to any municipality to appropriate waters shall not authorize the appropriation of any water for other than municipal purposes." The division has ruled in this connection that the application of the East Bay Municipal Utility District was an application by a municipality within the meaning of the term "municipality" as used in this section of the Water Act, and further held that the act contemplated a preferred priority for an application by a municipality for general municipal purposes as well as for only the domestic purposes of its inhabitants.

In the matter of flood control and the enroachment on delta lands of salt water as the result of diversion from Sacramento and San Joaquin tributaries, the division did not rule that special obligations in these connections devolved upon the district. The application of the district in the matter of irrigating some 200,000 acres of land in the vicinity of Stockton and Lodi was cancelled. Action on the District's application for power development at Lancha Plana dam was withheld pending a further hearing.

Certain responsibilities with regard to replenishment of underground waters and the use of the Lancha Plana dam are to be included in the permit.

The division announced that action on the Kieffer and Preston applications would be withheld for a short time in order that these applicants might have an opportunity to make a further presentation in the matter of feasibility and readiness to proceed, in view of the effect on their applications of this grant to the East Bay Municipal Utility District.

Engineer Sues Newspaper on Libel Charges for $250,000

W. R. Holway has brought suit in the district court of Tulsa County, Oklahoma against the *Tulsa Daily World* for publishing a series of articles starting July 3, 1925, and containing alleged libelous and false statements concerning Mr. Holway's work as engineer on the Spavinaw water supply project for the City of Tulsa.

The articles published by the *Tulsa Daily World* stated in part that the Spavinaw project has failed to furnish water to Tulsa, that Mr. Holway was incompetent to perform the duties of an engineer, that he was connected in some dishonorable way with the water board's real estate transactions, that he had claimed and received money in excess of the amount to which he was entitled and that there had been reckless expenditure of the peoples' money for engineering carried out under his supervision. All these charges Mr. Holway refutes and has filed a petition in the district court stating five causes for action each of which is based on the statements publicly made in these articles.

Mr. Holway, in company with Colonel J. D. Trammel, was employed as engineer of construction and design on the Spavinaw project at the time of its inception. Colonel Trammel retired in 1923 and Mr. Holway took charge of all engineering work. The articles in the *Tulsa Daily World* state that outside advice is now needed to determine how the public moneys have been spent and what, if any, inefficiency and dishonesty has been practiced. It suggests Colonel Trammel as the party to make the survey.

Mr. Holway in his petition states that the articles not only have deprived him of many valuable contracts but also have exposed him to public contempt and ridicule. Actual damages to the extent of $200,000 and exemplary damages for $50,000 are asked for in the petition.

Statewide Crossing Elimination Started in New York

A start on the statewide grade crossing elimination in the State of New York under the recently approved $300,000,000 bond issue for such work was made by the State Public Service Commission on April 15, when it published a list of crossings concerning which it proposes to hold hearings in the near future. The commission hopes that actual work can be undertaken this year.

The program calls for the elimination of one hundred crossings distributed over practically all of the railroads in the state at an estimated cost of over $60,000,000. Under the grade crossing act the cost of this work is to be borne 25 per cent by the municipality concerned, 25 per cent by the state and 50 per cent by the railroad corporation. The railroads and the municipalities may borrow their respective shares from the state out of the proceeds of the bond issue. Counties, by a three-fourth vote of the supervisors, may assist municipalities in making payments.

Engineering Societies

Calendar

Annual Meetings

NATIONAL HIGHWAY TRAFFIC ASSOCIATION, Ann Arbor, Mich.; Annual Meeting, New York City, April 30, 1926.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, N. J., May 10-13, 1926.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Buffalo, N. Y., June 5 and 7, 1926.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Buffalo, N. Y., June 7-11, 1926.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Philadelphia, Pa., June 13-19, 1926.

SOCIETY FOR PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Meeting, State University of Iowa, Iowa City, June 16-18, 1926.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J.; June 21-25, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Summer Meeting, Seattle, Wash., July 14-16; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, Lawrence, Kansas; Annual Convention, Colorado Springs, Colo., Sept. 21-23, 1926.

The Texas Section of the American Society of Civil Engineers held its spring meeting in two divisions, a northern meeting at Dallas April 19 and a southern meeting at Houston the following day, the Dallas meeting including a trip to Garza dam. George E. Davison and George T. Seabury, president and secretary of the national society, attended both meetings.

The Detroit Engineering Society at its annual meeting April 17 elected the following officers: President, George R. Thompson, superintendent, Division of Municipal Waste, city of Detroit; vice-presidents, Charles J. Peck, manager of sales, Crane Co., and William F. Zabriskie, vice-president and general manager, Gabriel Steel Co.; secretary-treasurer, Donald K. Williams, district sales manager, Elliott Co.

Personal Notes

H. H. KRANZ, civil engineer, has been appointed superintendent of street maintenance and repair for the city of Cincinnati, Ohio. Mr. Kranz is a graduate of the College of Engineering of the University of Cincinnati and has served the Cincinnati office of United States Engineers, some industrial companies in Cincinnati, and recently the Pennsylvania Engineering Works at New Castle, Pa.; also, he served overseas as captain of engineers.

WALTER N. POLAKOV is president and WALLACE CLARK is vice-president and secretary of the newly organized American Engineering & Sales Corporation which has opened offices at Washington, D. C., with branch offices at New York City, and in San Francisco.

W. M. SHANN, chief engineer of the construction division of the Missouri State Highway Department, has been promoted to chief engineer of division of surveys and plans; he succeeds M. H. MURRAY, recently selected as director of public works for Kansas City, Mo. T. H. CUTLER, assistant engineer of the construction division, will succeed Mr. Shann as head of that division.

FRANK M. TOWNSEND, formerly with the Union Pacific and Southern Pacific railways, has been appointed supervising engineer in charge of the construction of the Texistepeque-Soyopargo Line of the International Railways of Central America, Salvador Division, in place of N. HAMPTON, resigned.

Prof. FRANK A. HEACOCK, of the engineering faculty of Princeton University, has received the Robert Stewart Brooks fellowship, granted annually to a member of the Princeton engineering faculty, and will devote the summer to a study of hydraulic developments and municipal sanitary systems; he will visit the power plants in California, at Niagara Falls, Keokuk, and Muscle Shoals, and will study the sanitary systems of Chicago, Baltimore, New Orleans and Los Angeles.

COL. MARCEL GARSAUD, New Orleans, La., who has been chief engineer of the Board of Commissioners, Orleans Levee District, has been appointed general manager of the Board of Commissioners of the Port of New Orleans, commonly called the Dock Board, in which position he succeeds Commander John W. Walsh who last fall was appointed a member of the U. S. Shipping Board. Colonel Garsaud was born in Bordeaux, France, and graduated from Tulane University in New Orleans in 1903. For some years he was assistant engineer of the New Orleans Sewerage and Water Board, on sewer construction and design, then devoted the years to 1917 to general construction work for a contractor, on highways, buildings, and harbor projects. From 1917 to 1919 he served in the Corps of Engineers, as colonel, both in this country and overseas. Private practice, as a member of Hackett & Garsaud, concerned with canals, levees, concrete, foundations, water-works, followed until, in 1924, the appointment was made to the Orleans Levee District. This assignment involved responsibility for flood control, extensive harbor work, and development of the water front of Lake Pontchartrain. Colonel Garsaud was at one time a member of the Louisiana state board of engineering examiners.

Obituary

MORGAN JONES, formerly a railroad contractor in Texas, died April 9 in Dallas, aged 83 years. Mr. Jones was born in England and started railroad work in Wales. He came to America in the 1860's and among lines which he built in whole or in part are the Texas & Pacific R.R., Fort Worth & Denver, Abilene & Southern, various Santa Fé branches and extensions, and Kansas City, Mexico & Orient.

HERBERT L. NAGEL, civil engineer, San Francisco, Calif., died suddenly at Miami, Fla., April 8, aged 38 years. Mr. Nagel was born in Bellevue, Ky., and was a graduate of the University of Kentucky. His professional career involved railroad location in the west, connection with the sewerage and subway projects in Cincinnati, and service as engineer of design in water-works improvement at Akron, Ohio. During the war he served as first lieutenant and subsequently as captain of engineers on various assignments in this country.

LOUIS R. LEMOINE, chairman of the board of the United States Cast Iron Pipe and Foundry Co., Philadelphia, Pa., died April 23 in Villa Nova, Pa., after a brief illness. Mr. Lemoine was born in St. Louis, Mo., in 1859. In 1883 he went to Philadelphia and became associated with R. D. Wood & Co. In 1896 he became vice-president of the McNeal Pipe & Foundry Co. and held that office until the company became absorbed in the United States Cast Iron Pipe & Foundry Co.; for the latter company he was successively resident manager at the Burlington plant, eastern sales manager and director. Subsequently he became general manager of the New Jersey Zinc Co. though remaining a director of the United States Cast Iron Pipe & Foundry Co., but in 1910 he returned to the latter as second vice-president; he became president in 1911 and from 1923 on was chairman of the board.

HENRY C. THOMPSON, division engineer, New York Central R.R., with territory of Jersey City to Albany, died April 13 at his home in Bogota, N. J. Mr. Thompson was born in Troy, N. Y. in 1861. Following an early apprenticeship in surveying at New York City, he went west for railroad work, first in Colorado, and later on the Santa Fe System. Subsequently he attended the Columbia School of Mines from which he was graduated in 1886. A term of service with the Suburban Elevated Railroad was followed by a residency for the Orange Mountain Land Co.; a year or more in private practice in New York City and then an appointment as supervisor of bridges and buildings for the New York Central R.R. with headquarters at Weehawken, N. J. Later came promotion to division engineer and personal direction of the reconstruction of the West Shore bridges to carry heavier motive power.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Second Annual Outdoor Road Show for New England

The second annual road building machinery and materials show will be held on May 13 and 14 at Cottage Farm Bridge on Memorial Drive, Cambridge, Mass., under the auspices of the Massachusetts Highway Association, in co-operation with the various manufacturers and distributors of equipment and materials. Applications for space should be made out to J. O. Jordan, Jr., c/o Hedge & Mattheis Co., 50 Dorchester Ave., Boston, Mass. There is no charge for exhibit space and incidental expenses are estimated to be about $30 per exhibitor.

Simplified Trade Cataloging

A simplified method of cataloging the various products of its business in such a way that it can be properly filed is being introduced by the Lee B. Mettler Co., Los Angeles, Calif., manufacturer of combustion gas burners. This "catalog" is printed on both sides of a single sheet of heavy press board, 10 x 11⅝ in. in size, to fit the standard letter file. The Mettler company has applied for a patent covering this system.

Business Notes

NATIONAL SLAG ASSOCIATION, Cleveland, Ohio, held its ninth annual meeting in Cleveland on April 9. The honor guest at the convention was P. H. Bates of the United States Bureau of Standards. The following officers were elected to succeed themselves for the coming year: President, C. L. McKenzie, Duquesne Slag Products Co., Pittsburgh, Pa.; vice-president, C. E. Ireland, Birmingham Slag Co., Binmingham, Ala.; secretary-treasurer, H. J. Love.

CONSTRUCTION MACHINERY CO., Waterloo, Iowa, has appointed the Cunningham-Ortmayer Co., Milwaukee, Wis., and the R. E. Brooks Co., New York City, as distributors for its line of mixers in their respective territories.

BROWNING CRANE CO., Cleveland, Ohio, has recently opened a new branch office in Pittsburgh, Pa., in charge of D. C. Harris.

MUNDY SALES CORP., 30 Church Street New York City, announces the appointments of some new distributors: W. Fred Casey Company, Charlotte, N. C., in the state of North Carolina; Yancy Bros., Atlanta, Ga., in the states of Alabama, Georgia, South Carolina and in the western part of Florida; Earnest Bros., Richmond, Va., in the state of Virginia; Franklin Taylor, West Palm Beach, Fla., in the counties of St. Lucie, Martin and Palm Beach, Fla.

THOMAS & BUCKLEY HOISTING CO., New York City, has been acquired by the United Hoisting Company, Inc., the new company to be known by the latter name.

GEORGE W. KIRKLEY, for 12 years connected with the U. S. Steel Corporation, has accepted appointment as sales agent of the Washington Steel Form Co., Washington, D. C.

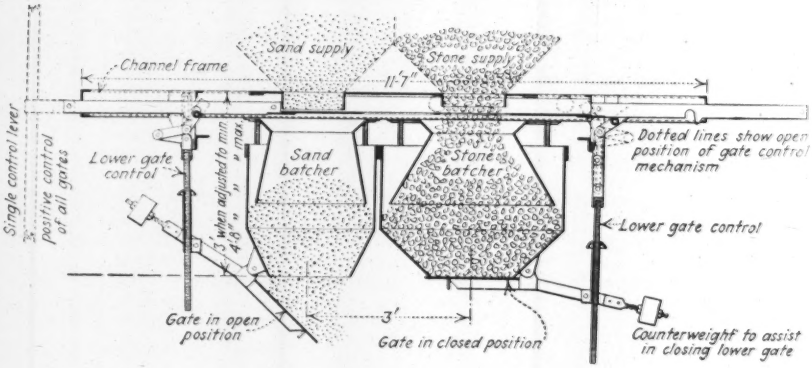
Equipment and Materials

Synchronized Batcher-Hoppers Used on Trailer Bin

The measuring hoppers used with the trailer bin, as shown in the illustration, constitute the most recent addition to the contractor's equipment manufactured by the Heltzel Steel Form & Iron Co., Warren, Ohio. The measuring hoppers are cylindrical in shape, and are attached to a steel channel frame, making the batcher a complete unit in itself.

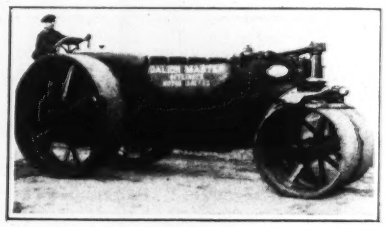
The batcher is operated with a single lever which performs the complete operation of filling, cutting off, dumping the batch of sand and stone, closing the lower and opening the upper gates. Thus all operations are synchronized and are performed by moving the single control lever shown in the sketch. One of these outfits was operated by electricity at the Road Show in Chicago, the batcher gates opening and closing continuously during the four days of the show, and making about 60,000 operations. It is claimed that the equipment has a batching speed of 6 batches per min. when manually operated.

The trailer bin is portable, the running gears being plainly shown in the illustration. The equipment is merely tipped over by the crane and hooked to the rear of a motor truck. The Alemite lubrication system is used. These bins are made in only one size, 35-ton capacity, and are arranged for attaching a standard top extension to increase their capacity to 55 tons.



Heavy Duty Road Roller Features One-Half In. Steel Plate Frame

The new 10-ton road roller manufactured by the Galion Iron Works & Mfg. Co., Galion, Ohio, is powered by a 55-hp. Climax gasoline engine. Two speeds, forward and reverse, give a range of 1½ to 3½ m.p.h. By the use of



lock pins the entire power of the motor can be applied to either drive wheel or to both equally, cutting out the differential entirely.

A special feature of the equipment is the half inch steel plate frame tied together and braced by heavy crossbars. The motor and transmission form an additional brace while the rear

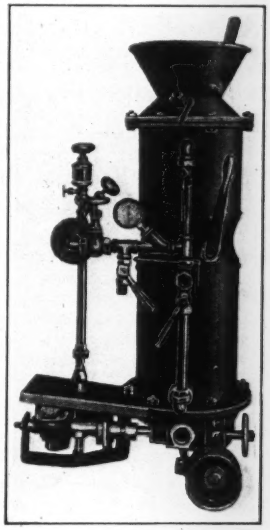
of the frame is braced by the heavy steel platform, tank and breastplate. The front end of the frame is riveted to a heavy steel casting which forms the housing for the front roll mounting.

The two front rolls of cast iron run on the same axle but are independent of each other. They have a diameter of 44 in. and a total width together of 44 in. Lubrication for all the moving parts inside the frame, not lubricated by oil in transmission, is taken care of by six Alemite grease cups on the breastplate of the platform. Hyatt roller and New Departure ball bearings are used.

The scarifier has reversible teeth 30 in. long and 2 in. square, standing at an angle of 45 deg. Pneumatic pressure is supplied by a gear driven compressor. The width of the scarifier is 6 ft.

Portable Cement Gun Requires Small Amount of Air

A one-drill compressor is claimed to furnish sufficient air for the operation of the new type N-00 cement gun manufactured by the Cement-Gun Company, Inc., Allentown, Pa. It is of especial advantage to contractors, for the repair of honeycombed concrete and for other small patch work because of its easy portability. Sixty cu.ft. of free air per min. is given as the required air supply of the machine. Its operation is identical to that of the larger machines and it is claimed to be just as efficient in operation. Its weight is 200 lb.



Cast Iron Culvert Pipe Made In Two Half-Round Sections

What is considered by the Alabama Pipe Co., Anniston, Ala., the most important characteristic of its cast iron culvert pipe is the fact that each 4-ft. length is made up of two half-round sections. The sections are exactly alike and interchangeable. In case of trouble inside the culvert, one of the 4-ft. top sections may be removed, the culvert cleaned and replacement made without disturbing the major part of the installation.

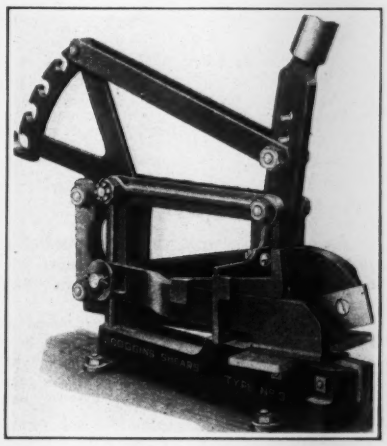
As shown in the illustration, cross-ribs are cast on the outside of the pipe. It is claimed that because of these cross-ribs, loads tend to react throughout the entire section of the culvert resulting in unusual flexibility. The inside bore of the pipe is smooth.

This pipe, which is known as Alpicul, is manufactured in 12, 15, 18, 21, and 24-in. diameters and 30- and 36-in. pipe can be quoted upon. The pipe

meets the requirements for load supporting capacity as prescribed by Committee C-4, A.S.T.M.

Light Shears Do Heavy Duty Through Compound Leverage

The portable shears shown in the illustration are rated for cutting up to and including ¾ in. round and square bars and 4x⅝ in. mild steel flat stock. The outstanding feature of the shears, which are known as the Scoggins shears and are marketed by the Industrial Sales Corp., 443 South San Pedro St., Los Angeles, Calif., is the patented application of compound leverage. The shear is so arranged that various compounds may be used at the will of the operator, yet, in each event, the lever fulcrums are so located that a slight pressure exerted upon the handle is compounded several times before it is transferred to the jaw carrying the cutting blade. Links are used to connect each pair of levers so that all parts of the leverage system are in tension rather than compression or torsion. This in addition to the fact that electric steel castings are used throughout is claimed to make a much lighter sectional construction possible. The weight of this type of shear is 90

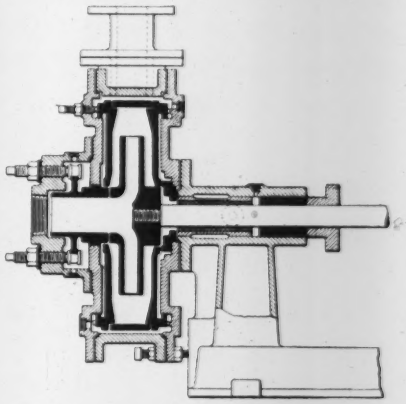


lb. A patented method for hinging the upper jaw is claimed to eliminate any possibility of misalignment of the cutting blade. The handle pulls down directly above the cutting blades, assuring the operator complete visibility and accurate work.

Sand Pumps Use Renewable Liners

The new sand pump of the Krogh Pump & Machinery Co., San Francisco, Cal., is entirely lined with removable hard liners ground to fit. The impeller is of the enclosed type arranged with a large clearance between the sides of the impellers and the liners so that the wear take-up can be adjusted many times before the parts are so worn that they have to be replaced. No bolts or screws pass through the liners, the inner surface being smooth. The liner is made in three parts, the two side liners which are most subject to wear being separate from the main peripheral liner. The impeller is threaded to the shaft so it can be removed and replaced without pulling the shaft from the pump. There is ample clearance between the impeller and side liners.

The particular feature of this pump is the arrangement to take up the wear without frequent replacement of parts. This wear take-up consists of a hard ground suction nozzle engaged by two threaded screws held with lock nuts fastened to the suction cover. Tightening these screws reduces the clearance between the nozzle and the runner hub.



This adjustment can be made while the pump is running. The bearings are of the ring oiling type, one on each side of the pulley. The thrust bearing is entirely enclosed and runs in oil.

Publications from the Construction Industry

Water-Works — PITTSBURGH-DES MOINES STEEL CO., 805 Curry Building, Pittsburgh, Pa., has ready for distribution a new booklet entitled "Municipal Water-Works." The booklet treats such subjects as the advantages of gravity pressure water systems, elevated steel tanks, and steel standpipes and reservoirs for municipal service, giving the specifications and capacities for all the different steel plate equipment furnished by this company.

Air Equipment — SULLIVAN MACHINERY CO., Chicago, Ill., has issued a road builders' and contractors' booklet illustrating such equipment as portable air compressors, rotator hammer drills, clay spaders, concrete breakers, port-

able hoists, etc. Tables of capacities and specifications are also given. The 16 pp. of the booklet are devoted almost entirely to construction views of the equipment. The booklet is called "Speed Up With Air."

Bilge Pumps—YOEMANS BROTHERS CO., Chicago, in its bulletin No. B-3300, describes its line of electric bilge pumps for automatically raising water or sewage from low levels to gravitation sewers in basements, subways, disposal works, etc. Specifications, line cuts, drawings, and illustrations are used in the bulletin.

Railway Ditching Machine—AMERICAN HOIST & DERRICK CO., St. Paul, Minn., has issued a description of its locomotive ditching machine, with itemized operating expenses, in a 12-page pamphlet. As this machine can handle the dump cars at 15 m.p.h. it dispenses with the need of a locomotive for the ditching train.

Incineration — DECARIE INCINERATOR CORPORATION, New York City, has just issued a 50-p. booklet devoted to the disposal of city refuse by incineration. After devoting about 20 pp. to generalities on methods, and cost of collection and final disposal, together with notes on the selection of plant and a complete description of the Decarie system, the balance of the booklet is devoted to descriptions of existing plants using the Decarie system. These descriptions are complete with photographs and drawings which add considerably to the usefulness of the booklet.

R.R. Yard Equipment — GENERAL RAILWAY SIGNAL CO., Rochester, N. Y., has issued in a 42-p. pamphlet a description of its electrically operated car retarders for controlling the movements of freight cars in gravity switching. There is also a description of the extensive installation of this system in the East St. Louis hump yard of the Illinois Central R.R.

Power Shovels — MARION STEAM SHOVEL CO., Marion, Ohio, in a 16-p. booklet, called "Crowding the Blasting Crew," describes and illustrates the use of its various types of shovels and cranes as used in the stone quarrying industry. Specification tables are given which are devoted to dimensions and working ranges.

Road Machinery — AUSTIN-WESTERN ROAD MACHINERY CO., Chicago, has recently issued its new general catalog No. 26. It contains 95 pp. and describes the entire line of road-building and maintenance equipment manufactured by the company.

Air Equipment — INGERSOLL-RAND CO., New York City, has made available a third edition of its book, "One Hundred and One Ways to Save Money With Portable Air Power." The title of the book explains its contents which consist of descriptions and illustrations, in many places including cost and other important data on uses to which the company's equipment has been put. The book contains 110 pages.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
April 29, 1926	$18,722,000	$26,101,000	$44,823,000
April 22, 1926	22,814,000	43,763,000	66,577,000
April 30, 1925	34,981,000	13,255,000	48,236,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
1926	301,483,000	578,662,000	880,145,000
1925	310,951,000	424,622,000	735,573,000

This Week's Special Tabulation of Unit Prices

4. Earth Excavation

These unit prices were included in low bidders' estimates on various sections of subway work in New York, Brooklyn, Flushing, Philadelphia, Chicago and Rochester:

Location	Date	Cu.Yd.	Price per Cu.Yd
Flushing	Nov., 1922	126,550	$4.40
Brooklyn	Jan., 1923	46,500	6.20
		175,000	3.70
Rochester	July, 1923	230,000	1.40
Philadelphia	Sept., 1923	70,000	8.25
Brooklyn	Oct., 1923	175,000	4.08
	May, 1924	196,050	6.90
	Oct., 1924	179,500	7.50
	Nov., 1924	660,000	10.70
New York	Feb., 1925	190,000	12.00
		186,000	9.00
	June, 1925	86,000	6.50
	Aug., 1925	600,000	7.30
Philadelphia	Aug., 1925	44,000	12.00
	Oct., 1925	22,800	11.00
New York	Nov., 1925	132,000	12.85
	Jan., 1926	200,000	12.50
	Feb., 1926	135,000	12.15
Chicago	Feb., 1926	29,000	1.65
New York	Mar., 1926	75,200	10.40
		121,000	12.00

5. Rock Excavation

Following are unit prices included in low bidders' estimates on various sections of subway construction in New York and Rochester:

Location	Date	Cu.Yd.	Price per Cu.Yd.
Rochester			
Contract No. 2	May, 1923	21,000*	$3.50
		3,000†	6.00
New York			
Sect. 3-A, R. 78	Jan., 1925	3,000	12.00
		62,000	11.80
Sect. 2, R. 78	June, 1925	126,000	13.00
Sect. 6, R. 78	July, 1925	232,000	12.00
Sect. 1, R. 5	Sept., 1925	91,600	11.00
Sect. 4, R. 102	Oct., 1925	155,000	12.85
Sect. 7, R. 78	Nov., 1925	70,000	11.50
Sect. 3, R. 102	Dec., 1925	23,000	17.50
Sect. 2, R. 102	Dec., 1925	75,000	17.00
Sect. 8, R. 78	Mar., 1926	550	11.00
Sect. 5, R. 102	Mar., 1926	171,500	14.95

*In grading. †In trenches and pits.

Foreign Projects of Interest to American Contractors

Among the world-wide construction reports received in the Machinery Division of the Department of Commerce, are the following projects containing opportunities for employment of American contracting organizations:

Market place, Ovideo, Spain, bids desired, 4,243,127 pesetas.

Dikes, levees, drainage of swamp land, proposed for Province of Seville, Spain. 12,000 hectares, estimated cost, 7,026,814 pesetas.

Dock extension, Southampton, England, Parliamentary powers already obtained, £3,000,000.

Road program, Antioquia, Colombia, proposed, $5,000,000.

Highway and railroad construction, Peru, South America, loan will probably be handled by American investors, $57,000,000 to $68,000,000.

Repair of roads and bridges, Rumania, $2,487,000 allotted for 1926.

Port improvement, Las Palmas, Canary Islands, decree grants 10,000,000 pesetas extending over a period of twelve years; 1,085,000 pesetas appropriated for each of the next three years.

Construction work in Hungarian cities, loan of $10,000,000 arranged. Public bids will be opened as soon as the Ministry approves expenditures.

Reconstruction program for New Zealand railroad shops, tenders called soon, entire project to cost about £1,500,000.

Gravel roads, Province of Alberta, Canada, probable construction during 1926, about 566 miles.

Bank, Lima, Peru, erection of new building contemplated within next twelve months, location chosen but purchase not yet made.

Now One Motor Car for Every 5.8 Persons in U. S.

Over 68 Per Cent of Revenue From Registration Fees, Etc., Made Available for State Highways

THERE were 20,051,276 motor vehicles in use on the highways of the United States in 1925, according to the Bureau of Public Roads of the United States Department of Agriculture. The total registration reported was 19,954,347, but there were in addition 96,929 State and Federal government-owned vehicles not included in this figure.

The total revenue from registration fees, permits, etc., amounted to $260,619,621, of which $177,706,587 was made available for State highways, $19,124,014 for State road bonds and $48,396,471 for local roads.

The increase in registrations during the year amounted to $2,360,670 or 13.4 per cent. Florida reports an increase of 46.8 per cent, while Utah, Mississippi, Alabama, Arkansas, North Dakota and Texas all report increases of more than 20 per cent. Truck registration increased 14.5 per cent for the entire country.

New York leads in total registrations with 1,625,583 followed by California, Ohio, Pennsylvania and Illinois in the order named, all with registrations of over a million.

There is now one motor vehicle for each 5.8 persons in the United States. California has only 2.9 persons for each motor vehicle, while Iowa has 3.6, Nevada 3.7, Kansas 4.0 and Oregon 4.0. At the other end of the list is Alabama with 12.0 persons per vehicle, but ranking among the highest in increase during the year.

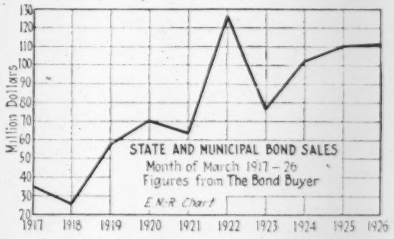
The total motor vehicle registration by States, not including official State and Federal cars and eliminating so far as possible re-registrations and non-resident registrations, was as follows:

Alabama	194,580	Nevada	21,169
Arizona	68,029	N. H.	81,198
Arkansas	183,589	New Jersey	580,554
California	1,440,541	New Mexico	49,111
Colorado	240,097	New York	1,625,583
Connecticut	250,669	N. C.	340,287
Delaware	40,140	N. D.	144,972
Florida	286,388	Ohio	1,346,100
Georgia	248,093	Oklahoma	424,345
Idaho	81,506	Oregon	216,553
Illinois	1,263,177	Penn.	1,330,433
Indiana	725,410	R. I.	101,756
Iowa	659,202	S. C.	168,196
Kansas	457,033	S. D.	168,028
Kentucky	261,647	Tennessee	244,626
Louisiana	207,000	Texas	975,083
Maine	140,499	Utah	90,500
Maryland	234,247	Vermont	69,576
Mass.	646,153	Virginia	282,650
Michigan	989,010	Wash.	328,442
Minnesota	569,694	W. Va.	217,589
Mississippi	177,262	Wisconsin	594,386
Missouri	604,166	Wyoming	47,711
Montana	94,656	District of Columbia	103,092
Nebraska	338,719		
		Total	19,954,347

Bond Market Gaining Strength in Sales for Municipal Improvements

STATE and municipal bonds placed during March totaled, $111,377,033 according to the *Commercial and Financial Chronicle*. This compares with $111,067,656 in March, 1925 and $146,940,816 for February this year which included the $75,000,000 New York City award.

The first quarter of 1926 shows a total of $329,931,094. For the same period in 1925 the total was $326,702,507; in 1924, $295,559,537; in 1923, $246,574,494. The chart includes total March sales for the entire U. S.


Million Dollars
STATE AND MUNICIPAL BOND SALES
Month of March 1917 – 26
Figures from The Bond Buyer
E.N.-R. Chart
1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

Among the large placements for the month of March are: the $14,000,000 4½s. Inter-State Bridge, Series A, by Port of New York; 8 issues of Cleveland, O., $8,416,000 4½s and $2,500,000 4¾s; 6 issues of Allegheny County, Pa. $6,589,000 4½s; $4,124,000 4½s of Philadelphia, Pa.; $4,000,000 5s of Los Angeles, Calif.; $2,000,000 4s. of Portland, Ore., and $2,000,000 5s. of Seattle, Wash.

The rates in the accompanying table ranged from 4 to 6 per cent. Most of the awards commanded a premium but a few placements were made at par or below.

Representative Public Bond Sales, March, 1926

State	Purpose	Amount	Rate per Cent	Sold For	Basis	Dated	Maturity	Purchased by
Maine	Highway and bridge	$1,500,000	4	99.62	4.07	April 1	1927-41	National City of N. Y. and others
Massachusetts	Met. Park Dist. Series	675,000	4	101.011	....	.....	1927-46	Curtis & Sanger and others
County								
Allegheny, Pa.	Road	2,400,000	4½	101.317	4.13	Feb. 1	1927-56	Union Trust Co. of Pittsburgh
	Bridge	2,100,000						
	Road	840,000						
	Bridge	630,000						
	Tunnel	510,000						
	Courthouse ext.	109,000						
Blount, Tenn.	Highway	150,000	5	104.60	4.66	April 1	1931-56	Caldwell & Co. of Nashville
Burke, Ga.	Road	100,000	4½	99.46	4.57	Jan. 1	1936	Hibernia Securities Co. of New Orleans
Benton, Ind.	Highway impvt.	24,000	4½	101.08	....	.....	.....	J. F. Wild & Co. of Indianapolis
Camden, N. J.	General impvt.	1,811,000	4½	101.35	4.23	April 1	1928-59	Redmond & Co. of N. Y. and others
Clinton, Mich.	Road	37,000	4½	100.34	....	.....	1927-31	Detroit Trust Co. of Detroit
Davies, Ind.	Hospital	80,000	4½	102.92	....	April 15	.....	Breed, Elliott & Harrison of Cincinnati
Elberton, Ga.	Bridge	36,000	4½	100.33	....	.....	1950-55	First National Bank of Elberton
Fayette, Pa.	Road	500,000	4¼	100.092	4.23	Mar. 15	1931	Union Trust Co. of Pittsburgh
Forsythe, Ga.	Court House	275,000	4½	100.10	4.49	April 1	1947-56	Federal Commerce Trust Co. of St. Louis and others
	School Building	250,000						
Graves, Ky.	Road	150,000	5	102.66	....	Sept. 1	.....	First National Bank of Mayfield
Green, Wis.	Highway	450,000	5	107.77	4.26	April 1	1938-41	A. B. Leach & Co. of Chicago
Highland, Fla.	Road	287,000	6	95.13	6.17	Jan. 1	1927-56	W. L. Slayton & Co. of Toledo
	Court House	212,000	5½					
Hamblen, Tenn.	Highway	68,500	4¼	101.28	....	Feb. 1	30 years	Bumpus & Co. of Detroit
Henderson, N. C.	Road and Bridge	850,000	5	100	5	Feb. 15	1928	Curtis & Sanger of N. Y. and others
Lucas, O.	Road Impvt.	195,874	5	102.93	4.39	Sept. 10	1927-36	Detroit Trust Co. of Detroit and others
Tom Green, Tex.	Road	500,000	5	102.22	4.82	Mar. 1	1927-56	R. J. Edwards & Co. of Oklahoma City
Stark, Ind.	Drainage	9,276	6	100.36	5.91	Dec. 1	1926-35	First State Bank of North Judson
Washington, Pa.	Road Impvt.	175,000	4½	104.08	4.22	Mar. 1	1941-52	Harris, Forbes & Co. of New York
Township								
Abington, Pa.	School	400,000	4½	.....	....	Mar. 1	1936-56	M. M. Freeman & Co. of Philadelphia
Monroe, Ind.	.....	15,300	4½	102.12	4.06	Feb. 20	1927-36	Fletcher American Co. of Indianapolis
Rostraver, Pa.	Road	40,000	4½	100.27	4.48	Dec. 1	1933-45	Lewis & Snyder of Philadelphia
Municipal								
Anniston, Ala.	Improvement	65,000	5½	100.15	5.48	Mar. 1	1926	Ward, Sterne & Co. of Birmingham
Attica, N. Y.	Highway	18,000	5	102.456	4.62	Feb. 1	1928-37	Myron W. Green of Rochester
Attleboro, Mass.	Water	55,000	4	100.23	3.97	Dec. 1	1926-40	Merrill, Oldham & Co. of Boston
Auburndale, Fla.	Water Works	75,000	..	95.20	....	Jan. 1	1932-56	W. L. Slayton & Co. of Toledo
Bartow, Fla.	Street Impvt.	225,000	6	98.50	....	Jan. 1	1927-36	Ryan, Sutherland & Co. of Toledo
Bedford, O.	Street Impvt.	23,046	5½	102.64	4.68	Dec. 1	1927-35	W. L. Slayton & Co. of Toledo
Bessemer, Ala.	Pub. Impvt.	135,000	6	103.15	5.34	Feb. 1	1936	Caldwell & Co. of Nashville
Billings, Okla.	Sewer	41,600	..	106.14	....	.....	.....	Branch-Middlekauf Co. of Wichita
Charlotte, N. C.	Water and Sewer	415,000	4½	100.969	4.41	Mar. 1	1928-66	Eastman, Dillon & Co. of N. Y. and others
	Street Impvt.	750,000						
	Building	295,000						
	Fire Equipment	60,000						
El Segundo, Calif.	Water Works	10,000	5	102.55	4.83	Jan. 2	1949-50	Aronson & Co. of Los Angeles
Greenville, S. C.	Water Works	500,000	5	105.20	4.59	Jan. 1	1965	E. H. Rollins & Sons of Boston and others
Hornell, N. Y.	Improvement	34,033	4½	100.16	4.43	April 1	1927-32	Pulleyn & Co. of N. Y.
Ironton, O.	Water Works	90,000	5	102.383	4.52	Mar. 15	1927-36	A. T. Bell & Co. of Chicago
Key West, Fla.	Public Impvt.	225,000	6	99	6.10	Jan. 1	1932-49	Weil, Roth & Irving Co. of Cincinnati
Miami, Fla.	Special Impvt.	2,650,000	5	98.16	....	.....	.....	Eldridge & Co. of N. Y. and others
Seattle, Wash.	Improvement	540,000	4½	101.14	4.41	Mar. 1	1928-56	Austin, Grant & Co., Inc., of N.Y. and others

The Weekly Construction Market

THE price trend in materials related to constuction is unmistakably downward; this is particularly true of steel. Cement quotations hold, with accustomed firmness, in all of the important centers. Brick, in the Northern districts, will probably show a seasonal rising tendency during the next four weeks, at least until the 1926 crop starts coming through.

Linseed oil rose 0.4c. per lb. at New York, April 23, bringing the price of raw oil in 5-bbl. lots to 11.5c. f.o.b.; the following day an advance of 2½c. occurred in Minneapolis, placing the market there at 12.7c. per lb.

Unseasonal slowness prevails in the pine lumber market all along the Atlantic seaboard with the possible exception of northern New York State.

Telegraphic reports to *E.N.-R.* from the Northwest fir district state that "surplus of logs in water at mills may close down numerous logging camps temporarily —although lumber sales are heavy, margin of profit to mill men is exceedingly close."

The average wage rate, for the entire country, of skilled building trades mechanics is slightly over 2 per cent above that of April, 1925. Cities, recorded by *E. N.-R.* since 1919, in which higher skilled rates have been recently granted the mechanics or are being demanded by them, follow: New York, Boston, Baltimore, Cleveland, Chicago, Pittsburgh, Cincinnati, Detroit, Dallas, and Kansas City, Mo.

Since February, the common labor market has been just about the same as a year ago. If the present trend continues, lower rates in this grade of labor are to be expected by midsummer, present curtailment of production in the manufacturing industries facilitating this.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.40	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$3.75
Structural rivets, 100 lb.	4.50	3.50	4.75	3.50	3.75	4.65	5.00	3.75	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.30	3.38	3.00	3.25	3.77½	3.20	3.25	2.30
Steel pipe, black, 2½ to 6 in. lap, discount	48%	44.3%	53.6%	55%	54.25%	36%	39.1@52.2%	45%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@52.60	46.35	54.00	49.20@50.20	53.00	64.00	52.00	55.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.10	2.32	2.84	2.31	2.65	1.42
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	1.60	1.65	1.90	1.80	1.50	1.25
Sand, cu.yd.	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	1.50
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	62.50	34.00	56.00	41.00	37.75	34.75	27.00	25.00	65.00
Lime, finishing, hydrated, ton	18.20	23.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl.	2.25@2.75	1.50	+2.25	2.25	1.35	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.50	10.50	+12.00	12.00	14.25	12.00	15.00	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0895	.10	.075	.....	.075	.....	.10	.12
Hollow partition tile 4x12x12, per block	.1112	.0895	.10	.075	.076	.075	.108	.10	.10
Linseed oil, raw, 5 bbl. lots, gal.	+.86¼	.90¾	1.13	.85	+.95¼	1.06	.96	1.12	1.10
Common Labor									
Common labor, union, hour	.62½@.75	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	82½	.45@.55	.35@.50	.50	.50	.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 93⅜c.; building laborers, 75c.; excavating laborers, 62½c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of April 1, the next on May 6.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.187). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net: 3½-in., $59.49.

Business Briefs

Call money quoted at 3½ per cent, Apr. 27; year ago, 3½ per cent.

Time loans: sixty-ninety days, 4 per cent; four-six months, 4@4¼ per cent.

Commercial paper: best names, 4 per cent; other names, 4½ per cent.

On April 1, 1926

E. N.-R. Construction Cost Index Number 207.05

E. N.-R. Construction Volume Index Number 240

For Explanation and Details of Indexes Since 1913
See the First Issue of Every Month